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ABSTRACT

This publication is one in a series of 12 giving the recommendations that were made for a broad and balanced education program in science for young people. Section one of this guide is concerned with science teaching in a multicultural society. Section two looks at the perceptions held by young people on the multi-cultural nature of science and offers examples of curriculum development undertaken by teachers. Section three describes efforts at two schools to develop an anti-racist and multicultural science curriculum and describes some notions of inequality in science. Section four explores teacher expectations and assumptions and their consequences. Section five examines ways to develop language in the science laboratory. Section six provides some suggestions for inservice activities. Section seven presents recommendations, publications, and a glossary. Also included are an introduction, references, and an appendix with a checklist for analyzing images in curriculum materials. (RT)

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SECONDARY SCIENCE CURRICULUM REVIEW

SSCR

BETTER SCIENCE:

Working for a multicultural society

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Curriculum Guides

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SECONDARY SCIENCE CURRICULUM REVIEW

SSCR

BETTER SCIENCE:

Working for a multicultural society

Curriculum Guide 7

Compiled by Christine Ditchfield

Heinemann Educational Books/Association for Science Education
for the School Curriculum Development Committee

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Contents

Introduction and overview 1

PART ONE **What should science education in a multicultural society be like?**

SECTION ONE **Science teaching in multicultural Britain and the SSCR** 6
by Peter J. Chamberlain

The SSCR aims 6
The role of practical work 7
Multicultural implications for content 7
Relating science and technology to society 8
Historical and cultural contexts 8
Science as a personal experience 9
The limitations of scientific knowledge 10
Conclusion 10

SECTION TWO **The contribution of SSCR groups to the development of science education in a multicultural society** 11
by Di Bentley and Christine Ditchfield

Introduction 11
Youngsters' views on the multicultural nature of science 11
Curriculum development work in the SSCR 12
The multicultural history of science 12
Contemporary practice in other societies 13
Drawing on the experience of youngsters 13
Using topics to counter 'scientific' racism 14
Developing the Review work 14
A word of caution 15
What do you think of it so far? Some youngsters' views about multicultural science 16
by Di Bentley

SECTION THREE **Approaches to curriculum development from both an anti-racist and a multicultural perspective** 18
by Susan Watts

School A: lower school syllabus 18
School B: 'foods' and 'science travels' 21
Conclusion 22

PART TWO **Specific issues**

SECTION FOUR **Assessment by profile** 24
by Jane Harrild

Aims underpinning science profiles 24
Educational questions which arise 25
Who is an ideal student? 25
Dangers of stereotyping 25
Action within the whole school 26

SECTION FIVE **Science education in and for a multicultural society: some language issues** 28
by Pauline Hoyle

Language development 28
Creating the proper climate 31

PART THREE **Steps a science department can take**

SECTION SIX **A process approach to in-service education for the science department** 34
by Martin Hollins

Destination: How can we agree or at least agree to differ? 34
Origin: Where are we at and how did we get here? 35
Route: In what ways do we bring about change? 35
Conflicts: What if the problems cannot be solved? 36
A shared expertise 37

SECTION SEVEN **SSCR recommendations and sources of information** 38

Recommendations 38
Useful sources of information 39
Glossary of terms 39

APPENDIX **A checklist for analysing images in teaching materials and curriculum resources: an in-service activity** 40

References 41

Foreword

This is the seventh in a collection of twelve Curriculum Guides from the Secondary Science Curriculum Review, published jointly by Heinemann Educational Books and the Association for Science Education.

A Directory of Resources and a book, *Better Science: Making it happen*, which tries to set the Review's recommendations in the context of the whole school, will appear at the same time as the Guides. These will, when taken with earlier and forthcoming SSCR publications, including those from local groups, constitute the recommendations which the Review is making towards a broad and balanced science education for all the young people in our schools. The series title 'Better Science' is thus both apposite and self-explanatory. It is hoped that the current phase of the Review (1986–89) will achieve successful implementation of the recommendations.

But what is the status of these new publications apart from reflecting the formal approval and support of our major sponsors, the School Curriculum Development Committee and the Association for Science Education? From what sources have the recommendations within them emanated? Those readers unfamiliar with the history of the SSCR will find it explained within the Guides; but most will be aware that it set out as a project which tried fully to involve the practising teacher in the development of solutions to the problem of science for all. Thus, although the Guides have been compiled principally by the Central Team of the Review, they draw on the work of thousands of teachers in working groups over the past four years. Although the work of many of the groups is referred to in the Guides, it is not possible to refer to it all. In the *Directory of Resources* readers will find details of what many of these groups have produced. The writing of these Guides, however, would not have been possible without the groups' existence and the Review Central Team hopes that the content of the guides truly reflects their work. Thus the pronoun 'we', used within them, often reflects the view, gleaned over five years of consultation, of the practising teachers involved with the Review. On other occasions it can represent the views of the SSCR as constituted by the Central Team and Steering Committee and it is hoped that particular usage will be apparent from the context.

Jeff Kirkham
Mick Michell
Jeff Thompson
Dick West
(SSCR Curriculum Guide Editors)

Introduction and overview

Science in the home the factory the local environment the hospital and TV studio are all featured in the work of SSCR groups. The attempt to make science education relevant to the present and future experiences of youngsters, whilst at the same time widening their perspectives, underlies much of this curriculum development work. Taking science outside the laboratory into the youngster's environment gives rise to the obvious questions 'Which youngsters?' and 'Whose environment?'.

Do the people and the environments pictured in these new materials reflect the reality of British society today? That is, a multicultural society of people from many different ethnic and cultural backgrounds. If we are talking of *science for all*, then ought not the images reflect the lives of all? If cultural variety is not represented in the resources we use in science lessons, then aren't we denying the existence of ethnic minorities in our society and excluding their experiences?

At the same time, if we fail to include the contribution of many diverse cultures to the development of science, we give the impression that no contribution was made. Yet a look at the development of scientific ideas demonstrates that our understandings have been influenced and continue to be influenced by philosophies from many parts of the world. Today, science is an international activity in which all nations are involved and new discoveries can potentially affect everyone's lives.

By broadening the base of science education, to show:

- the varied use of science across the world;
- the evolution of scientific ideas and scientific methods throughout history;
- the contribution of many cultures to the international activity of science;
- the limitations of scientific explanations;

we are provided with the opportunity to widen the educational experience of all youngsters. To date, much of the work on multicultural issues in science education has tended to centre on schools with large numbers of students from ethnic minorities.However, we would argue that it is an issue for *all* schools, every school after all is part of our multicultural society. Indeed, several SSCR groups have made it their task to explore this relatively new item on the curriculum development agenda. For example the Leicestershire 'Science Education for a Multicultural Society' group (**0.1**) acknowledge that:

> *Britain is today a society made up of people with many different cultural, religious and ethnic backgrounds and our pupils will leave school to study, work and live in towns and cities where people of diverse cultures live side by side. For schools in places where there are few people from ethnic minorities in Britain there are special problems if their students are to be prepared for life in most places in Britain today as well as in other parts of the world. Large numbers of pupils leave their home towns to work in places with very different mixtures of cultures from their birthplace.*

Therefore the group set themselves two aims:

1 *To investigate ways in which the science curriculum of all schools should reflect the many different cultures which make up British society today. This aim is relevant whether or not the school has significant numbers of students from the ethnic and cultural minorities in Britain.*
2 *To identify ways in which the science curriculum and teaching methods may be modified to serve pupils from different ethnic, religious and cultural backgrounds in schools.*

These aims have much in common with the 'Agenda for Multicultural Teaching' laid out in a recent publication from the School Curriculum Development Committee (SCDC) (**0.2**). Teaching is examined in terms of:

- *The particular needs of pupils of ethnic minority origin (including minorities other than those of Asian and West Indian origin);*
- *The need of all pupils to develop a positive approach to cultural diversity;*
- *The need to combat racial prejudice and discrimination wherever it occurs and to encourage positive inter-cultural relationships between individuals and groups.*

The two terms **multicultural** and **anti-racist** education are used frequently in this publication. To define these terms we draw on the SCDC publication cited above (**0.2**).
Multiculturalism stresses the need to acknowledge and draw upon cultural diversity. This is true whether a school has students from ethnic minorities or not. *Anti-racism* gives greater emphasis to the attitudes and practices which discriminate against some minority groups and which result in an unequal distribution of life chances. These two terms are inter-related as the following quotation points out:

...the celebration of diversity is no more than tokenism unless it is accompanied by a fundamental belief in the equality of individuals from every background. On the other hand, equality of outcomes is unlikely to be attained unless the educational system is permeated with a real and fundamental sensitivity to diversity and a formal curriculum response. The multi-cultural and anti-racist approaches are therefore not alternatives but interlocking parts of one whole; each is essential, but neither is sufficient on its own. Successful approaches and strategies draw on a range of perspectives and also take account of the need to develop among pupils a core of shared values which contributes to societal cohesion.

Articles in this publication examine some of the questions which are raised by adopting such approaches to the science curriculum. The SSCR believes these approaches are essential when planning future curricula and we end by stating our own recommendations for science teachers.

The organisation of the publication

Members of the Central Team did not feel adequately qualified to represent the different aspects of the debate about science education in a multicultural society. Thus we offered people working in the field the opportunity to present their own views.

This was done by writing to participants at the 'Science Education for a Multicultural Society' conference held at the University of London Institute of Education in February 1985. As a result, we are able to present six papers from individuals who have experience in addressing specific issues before finally presenting our own recommendations. The papers are 'starters' for discussion rather than definitive statements; the different emphases adopted by the authors reflect the nature of the debate about multicultural education. The views presented are not necessarily those held by the Review Central Team; they are those of the individual contributors. While a diversity of views are represented here, we do not pretend to have covered all aspects of the debate. Nor do the articles lead naturally from one to the other, though there is some purpose to placing them in this order. We suggest that readers can dip into this publication at any point depending on their existing experience of the debate.

The Curriculum Guide is divided into three parts.

The first part is **WHAT SHOULD SCIENCE EDUCATION IN A MULTICULTURAL SOCIETY BE LIKE?** It examines how the aims for multi-cultural education might be realised through science.

SECTION ONE *Science teaching in multicultural Britain and the SSCR* by Peter Chamberlain

The paper presents a general introduction for those who are unfamiliar with the issues. Peter takes the aims for science education presented in the Review's document *Science Education 11–16: proposals for action and consultation* (**0.3**) as a framework. He presents a number of general strategies and some specifically scientific ones towards using science as a vehicle to realise the aims for multicultural education.

SECTION TWO: *The contribution of SSCR Review groups to the development of science education in a multicultural society.*
by Di Bentley and Christine Ditchfield

What do you think of it so far? Some youngsters' views about multi-cultural science by Di Bentley

These articles look at some of the views of science which are held by young people. The authors attempt to translate some of the principles laid out in the first article into classroom practice. Drawing on materials produced by SSCR groups, they provide suggestions about how others might build on and further develop these approaches.

SECTION THREE: *Approaches to curriculum development from both an anti-racist and a multi-cultural perspective* by Susan Watts

Sue describes how appreciation of cultural diversity requires us to view science within its social, economic and political context. She identifies some principles which might underlie good practice and demonstrates how they inform curriculum development through case studies of work going on in two ILEA schools.

The second part – **SPECIFIC ISSUES** – focuses more directly on the notion of inequality and examines how some youngsters might unconsciously be discriminated against in science.

SECTION FOUR: *Assessment by profile*
by Jane Harrild

Jane believes that assessment cannot be viewed in isolation from the aims and objectives of the curriculum. She examines some of the implicit assumptions and expectations which as teachers we take into our classroom and explores their consequences for the assessment of youngsters.

SECTION FIVE: *Science education in and for a multicultural society: some language issues*
by Pauline Hoyle

There can be no denying the importance of language in the development of concepts in science. But is the language of science accessible to all? Pauline examines some of the

practical ways in which language can be developed in the science laboratory so that youngsters can gain a better understanding of important concepts.

The third part looks at **STEPS A SCIENCE DEPARTMENT CAN TAKE.**

SECTION SIX: *A process approach to in-service education for the science department*

by Martin Hollins

This article provides some suggestions for in-service activities for departments engaged in curriculum reform. Martin concentrates on identifying starting points or problems to be solved, ways to proceed and activities to engage in, which may help a department to move forward.

SECTION SEVEN: *SCCR recommendations and sources of information*

This final list of recommendations arises out of the discussions in the preceding papers. We suggest some practical ways in which we feel science education which encourages an appreciation of cultural diversity, challenges racism and is accessible to *all* young people can be helped to develop. An annotated list of publications is included, some of which have already been cited as references in the earlier sections, which should serve as a useful source of further information. This is followed by a glossary of terms.

We are aware that this publication is only a beginning as far as the exploration of such an important dimension of science education goes. Therefore we encourage readers to involve themselves in the debate, to raise their awareness and to develop their own curriculum strategies.

PART ONE

What should science education in a multicultural society be like?

SECTION ONE

Science teaching in multicultural Britain and the SSCR

Peter J. Chamberlain (School of Education, St. Luke's, Exeter)

The SSCR aims

The SSCR publication *Science Education 11–16: proposals for action and consultation* (**0.3**) lists a set of aims which, the authors suggest, should be satisfied to meet the demand for a broader and more balanced approach to science studies. The aims (Box 1) stated were in terms of what schools should provide, at appropriate stages, as adequate opportunities for all students.

a.1 explore the nature of the biological and physical environment through observation, experiment and systematic enquiry;
a.2 develop the ability to design and carry out experiments, evaluate evidence and solve problems;
a.3 study the key concepts and principles of science that are essential to an understanding of science as a way of looking at the world;
a.4 study those aspects of science that are essential to an understanding of oneself, and of one's personal well being;
b.1 use their knowledge of science to design and develop solutions to technological problems, to test and evaluate those solutions and to cost such exercises;
b.2 study the key areas of science and technology that relate to the world of work and leisure so that they are better able to participate in a democratic society;
b.3 study key concepts that are essential to an understanding of the part science and technology play in a post-industrial and technological society;
c.1 gain some understanding of the historical development and contemporary cultural significance of scientific principles and theories;
c.2 appreciate that technologies are expressions of the desire to understand and control the environment and that technologies change in response to changing social needs;
c.3 appreciate that past scientific explanations were valid in their time and that early technologies are still valid in some cultural contexts;
d.1 discuss, reflect upon and evaluate their own personal understanding of key scientific concepts, theories and generalisations;
d.2 explore topics or themes which exemplify the limitations of scientific knowledge as an explanation of the human condition.

Box 1 SSCR aims for a broader and more balanced approach (**0.1**)

With these aims as starting points, this paper seeks to explore some of the multicultural aspects of science teaching. It makes the assumption, strongly argued in the Swann Report (**1.1**), that *all* teachers should adapt their teaching to the changed nature of British society. This is a view often challenged by science teachers who feel that science is culture-free and argue that science teaching should be the same the world over. However, the cultural bias implied in such widespread popular misconceptions as 'scientists are men in white coats' and 'the only worthwhile science has been done in the West' is clear. This paper explores areas such as these and draws out some of the ways in which they affect science teaching.

Some may rightly say that many of the suggestions made here are not specifically multicultural, but are just facets of good science teaching. It is argued here, however, that they are particularly appropriate to education in a multi cultural society in which it is important to *make manifest* the worth of all members of that society. It is also often stated by teachers with few or no minority group students in their classes that multicultural education has no relevance to them. This view is vigorously rejected by the many who have worked in this area (such as the members of the Swann Committee) who argue that our society is mobile and, in the long term, it is impossible not to be aware of and influenced by its multicultural nature. Indeed the Swann Committee chose to call their report *Education for All*.

In many minds there seems to be confusion between the distinct yet related topics of 'Education in a British Multicultural Society' and 'Third World Studies'. Whilst not wishing to undervalue the importance of the latter, it is false and unhelpful to identify the problems of the Third World with those of racial minorities in Britain. For it is surely the case that the vast majority of black youngsters in our schools are British born and may have British born parents and grandparents. For this reason this paper makes only brief reference to the Third World.

What then of 'Science Teaching in Multicultural Britain'? Of prime concern must be the issue of racism which may be explicit or implicit and may be shown by both teachers and students. This concern is not restricted to science but it should, nonetheless, be a major concern of all science

teachers. Discrimination is associated with the formation of racial stereotypes which will be discussed briefly although the topic is not the prime subject of this article.

The role of practical work

a.1 *Students should explore the nature of the biological and physical environment through observation, experiment and systematic enquiry.*

a.2 *Students should develop the ability to design and carry out experiments, evaluate evidence and solve problems.*

With the advent of GCSE and its associated emphasis on practical work, in which students are expected to be responsible for the design and execution of their own experiments, a new opportunity arises to re-examine the role of practical work in school science. It is an opportunity, for example, to re-examine what is meant by proof, whether scientific facts (and scientists) are fallible or infallible, and to explore the nature of scientific evidence. We could learn from other cultures. For example, a recent article in *The New Scientist* (**1.2**) pointed out that Islamic scientists of the past have stressed the need for scientists to show humility, to recognise the limitations of the scientific method and to respect the object of their study. Humility and tentativeness in making conclusions are notable for their absence in present day school science and should be introduced.

In a related issue Professor Rattansi has criticised the 'discovery' methods used in the Nuffield approach to science teaching (**1.3**). He points out that the connections between observations and conclusions are often weak and this weakness is not made clear to the students. For example, the evidence presented in school science courses for the existence of atoms is tenuous, yet students brought up in the 'discovery' tradition may be led to believe that they have 'proved' that atoms exist. The student may well ask why previous generations and other cultures failed to make this self-evident deduction.

This presents a difficult problem because 'failing to see the obvious' is often interpreted as a failure by the scientists of the day, or a failure of other countries' science, with pejorative overtones. The development of scientific theories has been extensively discussed by such philosophers as Popper, Kuhn, and Feyerabend, who dismiss naive culpability.

Multicultural implications for content

a.3 *Students should study the key concepts and principles of science that are essential to an understanding of science as a way of looking at the world.*

a.4 *Students should study those aspects of science that are essential to an understanding of oneself, and of one's personal well being.*

Specific issues of content with clear multicultural implications are largely restricted to biology and are discussed in an excellent article by Michael Vance (**1.4**). By way of illustration, some of the difficulties which may arise when teaching evolution were shown in a recent edition of *The Times Educational Supplement* (**1.5**) where it was stated that an Islamic school would not allow the teaching of Darwinism; a wish shared by some fundamentalist Christian groups. Further difficulties can arise with Darwin's theory of evolution when it introduces the ideas of 'natural selection' and 'survival of the fittest'. These ideas, applied to human evolution, portray a sequence leading from man as an ape-like creature through to stone-age man, the hunter-gatherer, and finally to modern man. The process can be seen as one of progress and, all too easily, modern man can be identified with the economically successful white man surrounded by his technological 'goodies' while hunter-gatherer or stone-age man can be identified with those in nomadic tribal societies which are often described as 'primitive'. Using this model, a hierarchy of races can be inferred. It is important to stress that in actuality we are very ignorant about the origins of different racial groups and there is no evidence to suggest that any one racial group has evolved further than any other.

A second issue related to race is the one of racial stereotypes; the problem of associating particular characteristics, such as intelligence or athletic ability, with different racial groups. It must be emphasised, for example, that the available evidence shows that there is more variation within a group, i.e amongst the members of any one racial group, than there is between the averages of different racial groups. In classrooms with a wide racial mix, sensitive teachers might use data from the individuals in their classes to demonstrate this whilst studying classification. Stephen Gould's book *Ever Since Darwin* (**1.6**) and the booklet *Science Teaching in a Multiethnic Society II* (**1.7**) contain useful discussions on this. An example of teaching material related to stereotypes can be found in the 'Working with Science' booklet, *Questioning, Prejudice and Superstition* (**1.8**).

Issues of a cultural rather than a racial nature emerge when teaching about foods. Teachers can use this opportunity to discuss the range of foods eaten by different cultural groups in our society. Tables of foods showing their nutritional values should reflect this range. 'Nutrition Guidelines',

providing nutritive values of a wide range of foods, and a computer programme 'Nu-Pack' (1.9) have both been developed in ILEA specifically for ethnically mixed teaching groups. (Sections 2 and 3 also include references to other curriculum materials on this topic).

Parental attitudes to sex education may cause problems in school for any science teacher. In a multicultural school there could be particular difficulties for some groups, which the teacher should try to minimise. For example, the article in *The Times Educational Supplement* (1.5) mentioned above suggests that Islamic schools would not allow the teaching of sex education (see also 1.10).

Relating science and technology to society

b.2 *Students should study key areas of science and technology that relate to the world of work and leisure so that they are better able to participate in a democratic society.*

b.3 *Students should study key concepts that are essential to an understanding of the part science and technology play in a post-industrial and technological society.*

c.2 *Students should appreciate that technologies are expressions of the desire to understand and control the environment and that technologies change in response to human needs.*

The importance of this set of aims, stressing the need to relate science, technology and society, has been given public recognition with the publication of a number of 'Science in Society' resources, for example the recently published SATIS materials (1.11). GCSE now provides a structure for incorporating the work within main stream science courses. As far as the multicultural aspects are concerned, the obvious question to ask when confronting issues of science and society is 'What sort of society?'. Clearly Britain is multicultural and so courses should reflect this. Authors of science text books, for example, have a clear obligation in this matter. Great care should be taken when selecting photographs to illustrate their texts to include people reflecting the racial mix of the country. In so doing authors should be careful not to promote racial stereotypes so, for example,black or Asian people should not always be portrayed doing menial tasks.

At a more profound level there is the issue of technological change and the proposition that such changes, introduced to enrich the lives of some, may also have impoverishing effects felt by others.

There are diverse projections for the future of our society: to some there is a vision of positive progress and the expectation of improving standards of living. Innovation brought about by technological change is part of this vision and we look to our scientists and technologists for such innovations. However, rarely do we associate loss as well as profit with technological change. An instance when this does happen is with the projected building of a new motorway. Here most of us can experience the benefits of its convenience but at the same time deplore the destruction of a familiar environment. However, more usually, the profits of technological change accrue to us, the more affluent, whilst the losses are suffered by the disadvantaged. Frequently the disadvantaged are those from the Third World, who, clamouring for the technological 'goodies' of Western society, deplete their own mineral and agricultural resources. However, the underprivileged in our own society can also be the victims of technological innovation and this group includes a disproportionately large number from racial minority groups. These are major discussion points and so whilst teaching about control technology, for example, we might discuss the increase in unemployment brought about by the introduction of automation and the effect this will have on various cultural groups.

Historical and cultural contexts

c.1 *Students should gain some understanding of the historical development and contemporary cultural significance of scientific principles and theories.*

c.3 *Students should appreciate that past scientific explanations were valid in their time and that early technologies are still valid in some cultural contexts.*

School physics as currently presented does not encourage the development of these aims. Certainly it retains some Greek names, notably that of Archimedes, and it may, in passing, mention Islamic scientists in connection with astronomy, but the emphasis is on 17th, 18th and 19th century physics. The names in a secondary school physics book might include the following: Newton, Galileo, Watt, Hooke, Boyle, Kelvin, Joule,Young Faraday, Volta, Ohm, Ampere, Coulomb and Maxwell. Very little is ever made of the cultural contexts in which they worked, or of other contemporary work of lesser-known scientists. Also, with the exception of nuclear physics, very little of what is taught as school physics was discovered in the 20th century so that the recent contributions of American, Chinese, Indian, Japanese and Russian physicists are largely unrecognised.

School chemistry and biology are equally culpable. Chemistry, for example, dismisses the contributions of early chemists by labeling them

'alchemists'. Yet it is clearly nonsense to believe that all that these early scientists were trying to do was make gold or that they did not lay the sound foundations on which Dalton and others could base the atomic theory. We also ignore the fact that much of Newton's work could be termed 'alchemy'. In contrast to physics, however, school chemistry does acknowledge the discoveries of the 20th century with the study of organic chemistry, plastics and biochemistry. (See also the sources of information listed in Section 7 for this important area).

The danger inherent in the present situation, then, is that students can emerge from our schools with negative images of the science of non-Western societies. How should the science teacher attempt to dispel these images? The SSCR seems to be suggesting that some history of science should be included in school science courses, restricted studies should be used to enhance the teaching of science. These restricted studies should include the placing of European science in a world perspective and occasional biographical studies which should include those of scientists from a variety of cultures. In addition, posters displayed in the classroom or laboratory could help to create the necessary awareness which could also be reinforced with appropriate passages and illustrations from text books. As was stated in the introduction, this paper is not concerned with 'Third World Studies' and so no discussion is included in this section of the important issues related to intermediate or alternative technology.

Science as a personal experience

d.1 *Students should discuss, reflect upon and evaluate their own personal understanding of key scientific concepts, theories and generalisations.*

This aim for science teaching is important, not just for its multicultural implications, but because too many children from cultural groups in secondary schools reject science. Science is often perceived as a difficult subject suitable only for bright children. It is not seen as a personal and enjoyable experience from which *all* can benefit. The list of questions set out below has been formulated to stimulate discussion of some of the issues which might enable *all* students to find personal satisfaction from the study of science.

The language of science

Is the language used in science lessons such as to exclude certain students? This may be a particular problem for students whose mother tongue is not English but the specific and specialised vocabulary of the subject creates needless barriers for many whose mother tongue is English. A review of particular issues associated with learning in a multicultural classroom is given in an article by Sue Tunnicliffe (**1.12**) whilst a general discussion of the significance of language in science teaching is given in Clive Carre's book (**1.13**). (Pauline Hoyle expands this topic in her article in this Guide in Section 5.)

The learning style

Are students encouraged to develop their own ideas? Such development may result from some of the following:

- teaching which respects students' own ideas;
- teaching in which students are given significant responsibility for managing their own learning;
- the use of student-controlled discussion groups in which students are given the chance to develop their own thinking;
- an appropriate mix of project work, resource-based learning and whole class teaching;
- teaching in which cooperation between students dominates competition;
- teaching in which teacher's questions are equally distributed throughout the class.

One intention with all these ideas is that the culture and attitudes of the teacher should not dominate the class at the expense of any other cultures or attitudes. This should then allow all the individuals in the diverse group of students making up a class to feel the subject is their own. The philosophy implied by these ideas has recently been incorporated in a number of published science schemes, for example' Warwick Process Science' (**1.14**).

Practical work

Is this presented in such a way as to preserve a scientific mystique? This is significant because many youngsters and adults see science as part of 'the establishment'. The establishment to those from ethnic minority groups is perceived as being Anglo-Saxon. Strategies which dispel this image and make it obvious that science is for all must be seen to be beneficial and some of the following ideas may help. Use household objects where they are as satisfactory as specialised laboratory apparatus. This includes the use of tin lids on which to heat chemicals and the use of plastic cups or jam jars instead of glass beakers. Children should be encouraged to wear protective overalls but these need not be the traditional white laboratory coats. The shirt overall from the art department would do. Students can also be encouraged to try experiments at home. This, in addition to helping them realise that science can take place outside the laboratory, provides a bonus with the opportunity of parental involvement.

Related to this is the style in which the results of experiments are reported. A personal account is much more appropriate and honest than the traditional past-passive voice. (See Pauline Hoyle's article Section 5)

The final example relates to the kind of laboratory task which students undertake. There should be a significant shift away from the style of experiment in which there is a 'right' answer and those who do not achieve it are 'wrong'. Instead there should be more open-ended exercises in which students can plan their own experiments and evaluate their own results. Tasks should be chosen which are seen as relevant by the students: that is students are likely to be interested in knowing the outcomes of their experiments.

The laboratory layout

Does the environment encourage student participation? Such participation may be encouraged by a number of factors. These include displaying students' work, arranging furniture so that group work is possible and making some apparatus accessible. In some cases it may be appropriate to label cupboards in other languages as well as in English.

The points raised in this section have been developed much more comprehensively in a number of publications. A recent example is John Head's book *The Personal Response to Science* (**1.15**).

The limitations of scientific knowledge

d.2 *Students should explore topics or themes which exemplify the limitations of scientific knowledge as an explanation of the human condition.*

The notion of omnipotent science able to solve all man's problems has even less credibility now than it might have had, say in the 1960s. Now with the growth of the environmental lobby in this country, people are much more sceptical about the ability of science to improve the quality of their lives. Alternatives to the expansion associated with scientific materialism include the religious and conservationist stances. In a multi cultural society both these orientations provide material to illustrate this aim. For example, in the debate over research on human embryos the established Churches have failed to produce a unified view, and we have witnessed interactions between moral and scientific perceptions. For other groups in our society the religious perspective may be much more clear. For instance Islam opposes all experiments on human embryos. Indeed, in order to provide guidance to their scientists, early Islamic philosophers attempted to classify sciences as either 'praiseworthy' or 'blameworthy'.

At the school level other immediate practical issues may arise to highlight the differences between religious and scientific perspectives. For example, dissection of animal parts obtained from the butcher or abattoir greatly helps the teaching of some facets of biology. If these come from a pig, problems arise for Moslems, whilst similar difficulties occur for Hindus over the cow. Most teachers lack the understanding of the reasons for these convictions but one would hope that they would respect the right of children to hold these views.

Conclusion

As was stated in the introduction to this section, a number of the issues presented are not specifically multicultural but are intended to benefit all students. A summary of its over-riding philosophy would stress the need to relate the science taught to the target population. Having looked at the strategies advocated by those trying to encourage girls in science, a similar philosophy seems to emerge. These parallels can only be regarded as helpful and should make it possible for science departments to produce single policies for science teaching which will embrace the needs of all their students.

SECTION TWO

The contribution of SSCR groups to the development of science education in a multicultural society

by Di Bentley and Christine Ditchfield (SSCR Central Team)

Introduction

> *Science is, after all, an activity of human beings, acting and interacting. In fact it is a social activity. Scientific endeavour, including the development of technology, is determined by the cultural, religious, environmental, political and economic factors, and it is an activity in which the entire human race has been and is involved.*

This is a laudable statement from the Leicestershire SSCR Group (**0.1**) but is this notion that cultural, political and economic influences affect the way in which science is conducted in different parts of the world appreciated by students? Indeed do they know that it is conducted at all in countries other than those in the Western world? For those readers who are not yet convinced that the issues raised in the previous article have much to do with their own teaching, a look at youngsters' ideas might convince them otherwise. Therefore we begin this section by considering, in a limited fashion, the views of young people. We then go on to look specifically at the curriculum development which has been undertaken by some SSCR groups.

Youngsters' views on the multi-cultural nature of science

A Review group in Sheffield explored the views of science which are held by youngsters from different cultural groups (**2.1**). The Abbeydale Grange School in Sheffield conducted a two stage questionnaire with youngsters, taking a sample of young people from all five years in eleven schools (their own and ten others) and from cultural backgrounds which they designated White, Afro-Caribbean, and Asian. Their first questionnaire attempted to discover whether some groups of pupils were more interested in science than others. Their results seem to indicate that the pupils they called Asian had a greater preference for science than other groups, but the findings were not significant. Thus, we seem to be interesting all groups of pupils equally or turning them all off equally. However, that tells us little about youngsters' views of the multicultural aspects of science. For that we turn to the second part of the questionnaire.

Here the young people were asked to write down what thoughts came into their head when they heard the word 'science'. This evoked the common stereotypes about science from all the cultural groups: that is that science is about content and experiments, it isn't about everyday life, and you need to be very clever to do it. As one youngster expressed it:

> *Science is people with big brains with white cloaks on in laboratories mixing acids together to find things out. Doing experiments that a person wouldn't really understand unless they understood science.*

Another question that was of particular interest to us concerned youngsters' understandings of science as an activity in other countries. The findings indicate that many youngsters from all cultural backgrounds believed that science was different in different parts of the world, but fewer Afro-Caribbean and Asian youngsters believed this than white youngsters. Very few youngsters admitted to knowing very much about scientists from other countries. Those who did usually specified this as being part of their history lessons.

What did the teachers of Abbeydale Grange School make of this evidence? They summarised their findings about youngsters' attitudes to science with four questions for themselves (Box 2). We repeat them here, since we feel that they are valuable questions for any science department to ask itself.

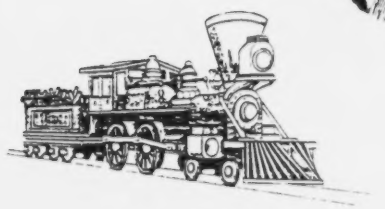
These student views have caused the Sheffield group to look more carefully at the ways in which they present science. Their work and that of other SSCR groups has provided us with pointers to how to address some of the issues.

Curriculum development work in the SSCR

The most comprehensive Review work in this area is from the Leicestershire group quoted at the beginning of the section who explain:

> *Given that science is a world-wide activity, the Working Group wished to look at possibilities in science teaching from four angles, all concerned with removing the Eurocentric, or perhaps more*

Elijah McCoy was an engineer who invented a device for lubricating locomotive engines. It was so successful that buyers only wanted machines that had the 'McCoy System'. They would always ask "Is it the real McCoy?"



Notes on Elijah McCoy

Elijah McCoy went to Edinburgh in Scotland to become an apprentice in mechanical engineering. After he qualified he could not get a skilled job because he was black. In 1872 he received a patent for a 'lubricating cup' which automatically oiled the machinery. He received many more patents before he died in 1929.

ELIJAH McCOY

Charles Richard Drew was an Afro-American scientist. He invented blood banks. Blood banks are a way of keeping blood so that it can be used for people who need transfusions.

Notes on Charles Richard Drew

Born and lived in ghetto in Washington. At University became aware of racism. Athlete in a team for University. Went to hotel after the game. The hotel wouldn't serve the black people in the team. In World War Two the Red Cross set up places for people to give blood. The army said that they wouldn't let black blood be used on the soldiers. A lot of protests were made. Eventually African blood was taken but kept separate from white blood. When Drew was in a car accident he wasn't far from a hospital. The hospital was using his discoveries. The hospital was in Alabama. It wouldn't take black people. Drew died.

CHARLES RICHARD DREW

Fig.1 Black scientists **(0.1)**

> *correctly, the white ethnocentric view of scientific developments, or with demonstrating how science can be used and misused in teaching about 'race'.* **(0.1)**

They then go on to list their four approaches:

- *Using science topics to consider the multicultural history of science;*
- *Making reference to contemporary practice in other societies;*
- *Drawing on the experience which some youngsters from ethnic minorities may have had personally or know about through their parents;*
- *Using topics particularly from the biological sciences to counter so-called 'scientific' racism.*

We will use these four approaches as the framework for the rest of this section.

The multicultural history of science

Much available material in this area focuses on the contribution of Western, white men. However, it is not difficult to find people from other cultures who have made and continue to make very important contributions. For example, the Leicestershire group provide profiles of a number of black scientists (Fig.1).

- **Is science culture free?**
  Abbeydale Grange say in answer to this: We would argue that if our pupils see science as being different in different parts of the world, then we must be attaching some values to it, making it different in different parts of the world in their eyes.
- **Should we place more emphasis on the human element in science?**
  Abbeydale Grange say: Yes, by helping our pupils appreciate a little about the background and history of scientists and scientific achievements, including a balance of examples from all over the world.
- **What picture do we give of science?**
  Abbeydale Grange say: If our pupils don't think all pupils learn science, then are we really training them to think about the world scientifically or just passing on knowledge appropriate to some people.
- **Is science appropriate to developing countries?**
  Abbeydale Grange say: If many of our pupils see science as needing to be conducted in laboratories with expensive equipment are we making it exclusive to Western technologies? By inference it is then only appropriate to the developed world — rather a poor reflection on us!

Box 2 The Abbeydale Grange School response to youngsters' views of science

Another section of their work is about the influence of science from India from over two thousand years ago on the development of medical sciences. For example there is both a written and a listening comprehension activity on the 'father of Indian surgery', Susruta (Box 3).

As well as providing historical material about scientists of other cultures, the effect of the history of science on the existing culture provides a fascinating context for science education. Exploration of the inter-relationships between science and culture can take place on the doorstep, as work from Wales demonstrates (**2.2**). Youngsters are encouraged to investigate their own environment to find out how science has affected the landscape and the social conditions through history. For example, one study revolves around the disused copper mining industry and is linked to their laboratory work on the chemistry of copper. Students are taken through the history of copper mining in the area. There are first-hand accounts of the environmental pollution caused by the copper smelters and which link to present day concerns about acid rain. The technological changes had enormous implications for peoples' lives with more housing, different working habits and the coming of the railway. Science is thus linked to the youngsters own cultural heritage.

Susruta was 'the father of Indian surgery'. He was a student of a later Dhanvantari. Surgeons at this time were called Dhanvantariyas, after the first Dhanvantari, who was known as 'the surgeon of the Gods'. Susruta lived some time between 1000 BC and 600 years BC.

The Indian word for surgery was Salyantantra. 'Salya' meant broken parts of arrows and 'tantra' meant manoeuvre — hence surgery was the removal of broken pieces of wood, etc., which got into the body as a result of warfare.

The Dhanvantaris spoke of eight main areas of medical science, and surgery was seen to be the most important.

Susruta made some general observations and stipulations. He said that knowledge of the theory of surgery without practical training is no good. As many attempts as possible should be made to get practical experience before performing surgery on a patient. A surgeon should also have a good working knowledge of anatomy.

A major development during this time was in surgical instruments. Susruta described dissection and the procedure to be followed and instruments to be used. He pointed out the hand is the most important instrument and other surgical instruments are no use without hands.

He described the uses of various instruments in some detail:

Blunt instruments — used for removing foreign bodies from wounds and holding back the skin and flesh so other instruments can be used.

Forceps — used to hold and pull any objects.

Tabular instruments — for sucking out fluids.

Sharp instruments — for cutting, scraping and performing blind surgical procedures at deeper, unapproachable places.

Needles and probes and spatulas — many uses were given according to the context.

Susruta's classifications and descriptions formed the basis of developing these instruments in later years. He also named instruments after birds and animals, hence we have crocodile forceps and hawkbill forceps today.

***Box 3** Material for a comprehension exercise*

Contemporary practice in other societies

This is a strong feature of the Leicestershire materials and of work from the Sheffield group. Both groups have drawn on existing published materials called *Third World Science* (**2.3**). For example, the Leicestershire group link work on 'Heat' to a study of house design throughout the world. While the Sheffield group provide information on the extraction and use of salt worldwide. (See also Section 3 for more detailed descriptions of similar work on salt).

It could be argued that these examples are only of 'appropriate technology' in the Third World and we are in danger of reinforcing the stereotypes of 'poor' ('appropriate') technology in the Third World and 'rich' ('high') technology only in the West. In fact we suggest that examples of different technologies are to be found in all parts of the world and warrant inclusion in any science course.

Drawing on the experience of youngsters

This teaching method isn't new to any teacher but how informed are we of the use of science in other cultures? The Leicestershire group provide details in the area of food preservation and dental health which make fascinating reading (**0.1**). At the same time, there is information about food and nutrition including calorie charts of foods which rarely appear in existing texts but which are part of the everyday diet of many youngsters.

> *Traditional lessons on nutrition and food, including food tests, have usually been developed around standard patterns of diet. This has given an undue emphasis to the single set of customs and may have encouraged young people to regard patterns different from their own as inferior. It is as important to give equal esteem to all diets which provide adequate nutrition as it is to discourage unsatisfactory, unbalanced diets.*
>
> Leicestershire SSCR report (**0.1**).

More important than already 'knowing about' other cultural practices is the teacher's skill in drawing out these varied experiences from the youngsters themselves. The climate of the classroom is obviously very important in this respect. A supportive and encouraging environment which values the experiences of all youngsters is obviously necessary. Strategies which enable them to talk

freely in small groups are helpful here. (Some such approaches are also explored in greater depth in Section 5).

Sometimes opportunities to draw on the experience of youngsters from ethnic minorities arise quite by chance as a group from Hampshire discovered when they were trying out part of their module on 'Communication' (**2.4**) which consisted of individualised learning activities with the theme 'sending a message'.

> *We had not been fully aware of the multicultural implications of the task 'writing in different languages' but the delight of the Bengali pupils on seeing the inclusion of the Arabic alphabet and their eagerness to share their knowledge was most rewarding and we hope to develop this further.*

Using topics to counter 'scientific' racism

The Leicestershire group point out that although publicly discredited, 'scientific' racism lingers on in the mythology of some. As they say (**0.1**):

> *... Science or 'psuedo science', has been used to justify racism and the oppression of minority groups at home and of conquered peoples abroad. Pupils should be aware of this misuse of science and at the same time be able to understand the basic sameness of the human race and the different ways in which groups have adapted to their environment.*

The example that the group use to raise the issue is that of sickle-cell anaemia. Although this is caused by a genetic trait which is found in people from many ethnic origins, it is only black people who suffer discrimination because of it as the excerpt in Box 4 shows.

Racism and sickle cell programmes

It is not uncommon to find references to literature which identifies sickle-cell anaemia as being 'a black man's disorder', or information which leads the reader to infer that this is so. In actual fact sickle haemoglobin is found in high frequency in Africans and their descendants, Greeks, Sicilians, Arabs, Turks, Southern Iranians, Asiatic Indians, some Native Americans and in some Mexican populations. On the basis of ill-informed categorisation a particular group may become the target for a genetic programme.

Another source of misinformation which gives rise to great concern is the failure to distinguish clearly between sickle-cell trait (HbAS) and sickle-cell anaemia (HbSS). Sickle-cell trait is not a disease. It is simply a carrier state. A person with sickle-cell trait usually has no symptoms and leads a perfectly normal life. Failure to differentiate sickle-cell trait from sickle-cell anaemia has also resulted in a magnification of the sickle haemoglobin problem.

The first line of the Federal Sickle-Cell Anaemia Legislation states that approximately two million blacks in the United States have sickle-cell anaemia, where in fact, about two million Afro-Americans have sickle-cell trait, not sickle-cell anaemia. Such misinformation could be used to reinforce negative attitudes towards a minority group readily distinguishable by virtue of its colour.

Mandatory sickle-cell screening laws have been passed in various states. The proponents of these codes perhaps did not realise that since sickle haemoglobin is found in many groups in the United States and since some persons who are classified as White have African ancestors, all Americans are potential carriers of sickle haemoglobin and therefore qualify for screening.

Many airlines do not permit employees who have sickle-cell trait to obtain flight status. Although high altitude flying in pressurised cabins does not lead to the sickling of red blood cells in sickle-cell trait, airline personnel can be grounded if they are trait carriers.

***Box 4** Topic used to counter 'scientific' racism* (**0.1**)

Developing the Review work

The curriculum development work presented here is only a beginning and provides examples of ways of moving towards a science curriculum for a multicultural society.

Readers who consider carrying out their own research and development work might consider trying out some of the methods employed by the Review groups. Here are some examples.

Investigating the images of science which youngsters have

The Sheffield group used questionnaires to survey youngsters attitudes and feelings about science. We have carried out informal interviews with groups of young people. (One such interview is transcribed in full at the end of this section).

Investigating the images of science which the current curriculum provides

The Leicestershire group provide a checklist for the evaluation of curriculum resources as follows:

- *Are the people featured in the material from more than one racial group?*
- *Does the material present a positive view of the different racial groups? For example, are the people of different races illustrated in tasks of equal esteem?*
- *Does the material present alternative views or life-styles and avoid the ethnocentric assumption that only Western ways are valid?*
- *Is modern technology and the application of science illustrated with examples from different parts of the world?*

(A further, more extensive checklist is provided in the Appendix).

Development of a policy for the science department.

From an initial consideration of the county policy, the Leicestershire group produced their own science department policy. Its aims and policy (0.1) were stated as:

Aims

The aim of this policy is to achieve better science education in two main ways. One is to provide a world view of science which emphasises the reality of science as an endeavour in which all people throughout the world participate. The other is to improve our teaching by responding to the particular needs of students from different cultural groups. Through this policy we also intend to promote positive attitudes in our students towards people of all cultures.

Policy

1 *We should draw upon material from a variety of cultures and countries throughout the world to illustrate our subject, so providing the world view of science.*

2 *We should make sure that we recognise, in our teaching, the contributions to the development of science which have been made by cultures other than those which are of European origin.*

3 *We should review our books, worksheets and other resources with the intention of replacing materials which are culturally biased.*

4 *We should identify the cultures represented among our own students and gather basic information about their distinguishing characteristics (for example, their religious beliefs, language and social customs).*

5 *We should review our science curriculum with the purpose of identifying areas where we think our curriculum or teaching method needs modifying to allow for the cultural characteristics of our students.*

6 *We should adapt our use of both written and spoken language to avoid penalising students with language difficulties, including students for whom English is a second language. Where appropriate we should make some use of the language of other cultures in our display or teaching material.*

7 *We should draw attention to ways in which scientific evidence is sometimes misused to assert a point of view, for example, inferiority of particular cultures or races.*

Develop your own curriculum materials and draw upon existing resources to demonstrate the policy in action.

Review groups have exemplified some approaches which we have summarised. Others have produced resources and ideas which we have found particularly useful and which are listed in the sources of information (Section 7), but there is still much to be done.

A word of caution

Much of the SSCR material has been generated with the purpose of showing cultural diversity in the applications of science and is a very useful addition to information in a much neglected area. The aim which underlies this material appears to be that of 'valuing other cultures'. However, presentation of information is not in itself going to achieve such an aim. Indeed, many would argue that, without careful presentation, this material stands in danger of reinforcing prejudice rather than challenging it. For example, the work on food preservation in the Leicestershire materials might be unfavourably compared to Western industrially packaged foods; without viewing the alternatives within a wider social and economic context, the Eastern alternative may be assumed to have little value and be viewed by students as 'less advanced'.

This brings us to a consideration of the assumptions *we* may make when presenting science. Do we for instance promote the notion that 'progress is a good thing' or 'prosperity relies on sophisticated, scientific developments' or do we also consider with students the negative consequences of increased technological sophistication? We would argue that without open exploration of both the benefits and the negative consequences of different technologies, as well as the appropriateness of their use in particular circumstances, then no matter how much cultural diversity is introduced into our science lessons, students may still place less value on practices which appear to them to be 'less sophisticated'. It thus behoves us to encourage discussion of values in science lessons.

What do you think of it so far? Some youngsters' views about multicultural science

by Di Bentley

This addition to Section 2 features a prolonged conversation between Di Bentley, a member of the Review Central Team, and six young people. The young people came from different schools, and were white British, black British of Afro-Caribbean origin, Indian and Pakistani. Both sexes were represented in the group and the young people ranged in age from twelve to seventeen. The conversation took place with the author in a youth club, so in some senses was an informal one, in that

it was deliberately not tied to a school atmosphere. All the youngsters were present at the same time, so some of the comments reported here are the result of discussions between the young people themselves, in arguing about their views.

The questions the youngsters were asked initially were deliberately drawn from the four questions the Abbeydale Grange teachers phrased for themselves. They were expanded and presented in a slightly different form to aid the youngsters' understanding. As the account is presented here, it has been tidied up a little to make it read more easily. It has also been presented as a more or less continuous account. In fact extraneous comments were bandied about between the youngsters from time to time, and there were many asides. Not all of these were easily captured by the tape recorder, and many of them were not pertinent to the main discussion. The account presented here has been edited where the discussion wandered off the point, and only the pertinent part of the youngsters comments are given. ('I' is Di Bentley.)

I: *Does every country do science?*
Paul: *Do you mean do they do science experiments? or do you mean do the kids do it in school...cos well... some countries do it don't they? I mean like America and star wars and that. That's science isn't it?*
Fitz: *Is it really science... I mean you said* (to Paul) *it was experiments and that. Is stars that? Russia doesn't have star wars but they do science...*
Sharon: *Yeah Russia does it...they had that man...you know that guy with the dog and the bell.*
I: *The guy with the dog?*
Sharon: *Yeah... you know we learned it in science. Something about ringing a bell when you fed it, and it expects it and sal...spit comes even if you don't feed it. He was Russian...*
I: *Can we go back to Paul's point? He asked if I meant what the scientists do or what the school children do. Do you think that in some countries children like you don't do science?*
Fitz: *Course not. In some countries they don't even go to school.*
I: *Like where?*
Fitz: *You know, in Ethiopia, in those camps that Bob Geldof goes to. And the rest of the place, where they live. They don't do science there.*
Pansey: *Why not? They might have schools in the camps.*
Fitz: *Yeah but they're not going to do science are they? I mean, they've hardly got any money for food, how can they build classrooms? Or have bunsen burners and that? Anyway it's not just those places where they're ... you know.... thingy.... in camps.*
I: *Refugees?*
Fitz: *Yeah. It's in other countries as well, where the people are poor and the kids don't go to school much. Like Pakistan and India.*
Sanjive: *That's not true. My dad's brother in Pakistan's got a science degree. He must have learnt science at school.*
Paul: *Yeah I bet he came over here to do it!*
Sanjive: *No, he's never been over here...*
Fitz: *Well my mum grew up in St Kitts and she never did any science. They didn't teach things like that she says. Only useful things, not boring old rubbish.*
I: *Can I just try and draw some of this together and see if you agree with what I think you've been saying. You seem to be saying that you know that science takes place in some countries. You gave me examples of Russia and America. You also say that young people like you don't learn science in some countries. The examples you gave me were poor people in the West Indies, India and Pakistan. Does anything strike you about the examples?*

It seems to us that in the discussion thus far, the youngsters were not dissimilar in their opinions to the ones in the Sheffield sample above.

Firstly their views of science (and science education) were those of a sophisticated technological activity which required expensive apparatus and special conditions for its execution. Some had stereotypic views of developing countries and the people in them. In these contexts science was not an activity that the people would have access to or necessarily need. Others, from their own childhood experience knew of science education and, by inference, scientific activities taking place in other cultures. What was plain was that apart from the example of a Russian scientist – presumably Pavlov – quoted by Sharon, their science education had done little to contribute to any views they might have held of multicultural images in science.

The latter part of the conversation focused upon what the young people thought science itself might be in other countries. Much of the earlier discussion had been about the science education available to young people like themselves. Later in the discussion, the interviewer returned to Paul's original distinction between science and science education.

I: *Can I just go back to Paul's point? It seems a long time ago! He asked if we were talking about science or science education. Can I ask you if science – the things scientists do for instance is the same in every country?*
Pansey: *Well we already mentioned Russia and America. They are doing different things.*
Sanjive: *No they're not ... its all space things innit?*
Sharon: *Space things aren't science. We don't do space things in our science.*
Fitz: *That's cos ours is school science. You heard what we said. It's about real science. Not school science... I think it's different in different places.*

I: *Why?*
Fitz: *Cos they got different problems innit? I mean ... if you're like trying to ... you know like them people we learnt about in geography, trying to grow things in sand ... to make crops grow better. They've got scientists trying to find out what kind of plants grows best. That's different from America and Russia innit?*
Jenny: *Yes it's got to be different in different countries.*
I: *Do you learn what happens in different countries then? In school I mean?*
Paul: *From the telly. But not in science lessons. We learnt about what they did in the old times in other countries in science.*
Sharon: *We never did that. It's like history that. Dead boring. Even worse than science lessons ... with all that equipment and things.*
I: *Is that what science is about then, just what people investigate?*
Pansey: *No, I think its about experiments.*
I: *What do you mean by that?*
Jenny: *It's doing things like testing using apparatus, doing controls or something.*
I: *So do you think everyone does their experiments in the same way? In different countries.*
Fitz: *Yeah, I mean ... science is ... like ... well ... it's experiments innit: How can you do it different ways? There can't be a West Indian and a Russian way of doing experiments can there?*

As we understand what the youngsters are saying here, there are three major points for science departments to take on board.

1 Young people need to address the issue of what science *is* in their science lessons. They have a view of it which is encompassed by content and experimentation, but they fail to conceive that the experimentation may be conducted differently by different cultures. Further that the questions which science is addressing, and the conclusions which it reaches, may well be different in different cultures.
2 Young people need to learn some of the personal and historical developments of science in other countries. If this aspect of science is tackled in science lessons, it may well give a framework for science which helps youngsters from different cultures to take a pride in their culture's contribution, rather than the stereotypic views that many youngsters how hold.
3 Youngsters need to have a debate about their views of science as a multicultural activity in science lessons. Listening to the discussion and argument between these youngsters, in which different cultural experiences were shared and explored, convinced us that such a debate was a very valuable learning experience which could be repeated in science lessons.

SECTION THREE

Approaches to curriculum development from both an anti-racist and a multicultural perspective

by Susan Watts (Secondary Curriculum Development Unit, ILEA Multiethnic Inspectorate)

In this article I will attempt to address some of the issues relating to curriculum development in science from an anti-racist and multicultural perspective. This discussion is based on my personal experience as an advisory teacher working for the Multiethnic Inspectorate of the Inner London Education Authority (ILEA) for a number of years. I hope to illustrate some of the points made by describing developments which have taken place in some ILEA schools.

General developments in the ILEA have taken place over a considerable number of years. What has taken place in schools has both preceded and been a response to policy statements made by the authority itself. ILEA was the first local authority to make a policy statement when , in 1977, a joint report was made by the Schools Sub-committee and the Further and Higher Education Sub-committee: *Multi-ethnic Education* (**3.1**). This was followed by a *Progress Report* in 1979 (**3.2**) and these were accompanied by the establishment of the Multiethnic Inspectorate and its support services. A substantial boost to work in progress and an impetus for further development was given with the launching of policy initiatives on 'Race, Sex and Class' in 1983 (**3.3—3.6**). These documents described an overtly anti-racist stance which, it was argued, was a change in emphasis from those taken previously. It was then up to teachers and schools to respond to these policy statements and undertake developments appropriate to their own situations.

There have, of course, been a number of teachers, departments and schools which have undertaken curriculum developments and policy statements on their own initiative before the issue of official

authority policy statements. These have often provided the ideas which others have needed to help them begin thinking about possible developments for their own situation. (See, for example, 3.7).

Following the development of whole school anti-racist policies, it was intended that individual departments and subject areas of schools would develop and implement policies. There has been some delay with developments in the subject areas of the secondary schools because of teacher action but much has been achieved. The accounts which follow describe developments undertaken in the science departments of two ILEA schools over the period of a number of years. I hope to use these accounts to illustrate some of the issues which need to be considered if we are to develop a science education which supports and encourages the development of equal opportunities for all. For me, this means we must adopt both an anti-racist and an anti-sexist perspective and must also address the issues of class inequalities.

These issues cannot be taken up only by science teachers or departments, they have to be part of the work of the whole school. It is important to bear this in mind while reading these accounts. It is, however, also important to recognise that the ideal situation rarely exists in schools or elsewhere. Just because there are no whole school policy or local education authority initiatives, there is no reason why we, as science teachers, cannot attempt to initiate developments and discussion within our own departments and in our own work.

School A: lower school syllabus

A school with a relatively new head of science and a newly written lower school syllabus seemed to present an ideal opportunity in which to be invited to work as an advisory teacher on a regular basis. This proved to be so.

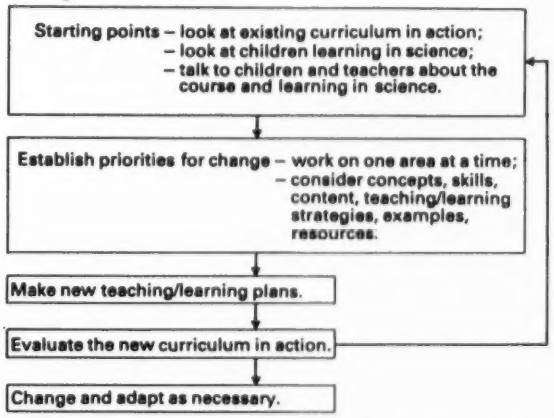

Starting points – look at existing curriculum in action;
– look at children learning in science;
– talk to children and teachers about the course and learning in science.
Establish priorities for change – work on one area at a time;
– consider concepts, skills, content, teaching/learning strategies, examples, resources.
Make new teaching/learning plans.
Evaluate the new curriculum in action.
Change and adapt as necessary.

Fig.2 Diagram to summarize stages in the development of a lower school sciece course using an anti-racist, multicultural perspective.

We decided that before attempting any new curriculum developments, we needed to observe the existing curriculum in action in order to assess what changes would be useful and where change would be most effective. We decided to concentrate on the lower school (11–13) curriculum as we felt that not only was this an area where changes might well be easier to effect but also that this was an age group where the attitudes of pupils towards science and learning in science were developed. On balance, I feel that this was a good decision for this particular school but that we did not give enough consideration to how we might have extended the approaches we had developed into the work of the whole of the department instead of leaving them with lower school classes.

We designed a diagram (Fig.2) to summarise our approaches to curriculum development. It illustrates the way we tried to work but as always, things did not always happen in exactly this way. After observation of a number of first and second year classes and much discussion with both teachers and children about what they were doing, what science was about and how we learn things in science, we decided to develop the lower school science course with the following aims in mind:

1 To give a wider social perspective to the work, particularly a multiethnic one.

2 To include more reading.

3 To update the view of technology we give in our applications of science.

4 To show science as an activity carried out by people everywhere.

5 To attempt to correct the view of science as pure research.

6 To show how science and technology change the world we live in.

7 To show how we make use of technology.

These aims were written a number of years ago (3.8) and I suspect that we would express them differently now, though their meaning would not be substantially altered.

I am often asked what is it about an anti-racist and anti-sexist approach which distinguishes this from notions of good practice in science education and curriculum development. Is this a meaningless question: surely 'good practice' must be anti-racist and anti-sexist? However, most of us probably understand what the questioners are actually asking. In attempting to answer the question I quote from a draft list of general principles for a science education which promotes equal opportunities and which was developed by a workshop of science teachers and teacher educators held by the Commission for Racial Equality, in Birmingham, March 1986. This is shown in Box 5.

General Principles

- Incorporating a global perspective
- Understanding issues relating to justice and equality
- Elaborating science in its social, political and economic context
- Making apparent the distribution of and access to power
- Making all people involved in science overt and not hidden
- Incorporating a historical perspective
- Starting from and valuing the experience and knowledge of children
- Using flexible teaching and learning strategies and giving emphasis to the learning of science
- Integrating practical approaches with the work as a whole

***Box 5** General principles from Commission for Racial Equality workshop drafts* (**3.9**)

The members felt that the first six of these principles were those which uniquely distinguished an anti-racist (and anti-sexist) approach.

We described some of the work we had done in a chapter of the book we published in 1984 (**3.8**) and I do not intend to repeat this description. Rather I am going to attempt to describe briefly what we did, not only in the light of our original aims, but also of the principles listed above.

It had become apparent from our discussions with the children that there was not enough for them to read about the science they were doing. We therefore decided to write some booklets which were to be used as an integral part of the science work to be done. These were not merely to be used as extension or cover work but as additional resources which could be used by all pupils. We have produced three of our own booklets so far: *Homes: places where people live; Salt;* and *Plants.*

Homes

The *Homes* booklet is part of a unit called 'Hot and Cold' which was developed from previous units on 'Heat' and 'Size, Surface and Movement'. These original units were considered to be unsatisfactory by both teachers and pupils. They caused difficulties in understanding for the vast majority of pupils, adopted a very narrow approach which was decidedly Eurocentric and used examples of out of date and irrelevant technology and applications of science. This area was given priority for change because the old topics were those which gave most problems and difficulties to both teachers and pupils.

In the *Homes* booklet we tried to incorporate a global perspective to the question of how people solve the universal problem of providing themselves with shelter. We attempted to put this into a social and economic context but omitted to consider political issues or to investigate the possibilities of using this topic to develop issues of power or justice. One of the resources which we found extremely useful in preparing this booklet was *Housing* from the Third World Science Project (**2.3**). We used this to write two of the case studies in our booklet. The first contains accounts written by third year pupils from a school in Zambia about different types of housing. Part of this section contrasts modern and traditional houses and could provide a very useful discussion starter for consideration of some of the power issues which we did not originally develop. The second case study is an account of an intermediate technology township in Ghana which we called 'A New Town in Ghana'. We believe that this helps to counteract some of the stereotypes held about people in Africa always living in mud huts or jungles. For the other two sections of the booklet we drew on the experiences of teachers within the department. The third case study was written by cousins of one of the teachers about their timber house in Canada. We decided to call the fourth section 'Living in South London' and hoped, possibly in a second edition, to use accounts written by some of the pupils. For the first edition we wrote accounts of our own homes emphasising links with ideas of energy and heat conservation, ventilation and building materials used. The final activity suggested in the booklet is that children write about their own homes in this way.

Salt

The second booklet *Salt* was written to accompany revision of a first year unit on 'Making Stuff Purer'. We felt that some of the practical activities provided for the pupils were at best very artificial. The separation of a previously made mixture of salt and sand bears little relation to real separation methods used for obtaining salt. Salt, as a chemical essential to all people, is obtained in a number of ways which vary throughout the world. We wrote about these ways in the booklet using the Third World Science materials as one of our main sources of information for some sections. One of the practical activities undertaken by pupils in this unit is the solution of the problem of obtaining salt from plant materials (a source of salt for people in some parts of the world). The booklet also contains sections on salt in history, salt in the diet and salt and health. Activities which have followed from this have included surveys of content labels on food packages to find the salt. Pupils have been very surprised how common an ingredient salt is in processed foods. This can give rise to many discussions of health and economic issues.

Plants

We decided to develop the unit on plants which comes in the summer term of the first year because

we found that few pupils related to the content and approaches of the exsisting unit. We therefore decided that we would make the experiences of the pupils one of the main starting points for our curriculum development.

After much discussion we came up with the idea of making four 'shops' with an accompanying booklet *Plants*. Each shop is a display of pictures, photographs, packages and samples of items to be found in the shops which are plants or directly derived from plant materials. The shops we chose were:

A grocery shop
A DIY shop
A sweetshop and newsagent
A fruit and vegetable shop.

The booklet serves a number of purposes. There is general information on plants and then sections about items in the individual shops. We hope that the booklet, questions and activities which accompany the shops provide opportunities for the discussion of many issues. These can include:

- cash crops like tea, coffee, cocoa and the effect that growing these has on food production;
- use of tropical hardwoods from the rain forests and the dangers of deforestation;
- health education topics including smoking, diet and nutrition.

Reference to the list of principles outlined earlier will suggest that all these issues and the others which arise have to be considered in their social, political and economic context as far as is possible. It also follows that the incorporation of a global perspective and discussion of some issues relating to the distribution of and access to power are possible here.

Classification

When we discussed developing a section of work on classification for first years we felt that the development of an understanding of the uses, possibilities and limitations of scientific ways of classifying would be an important element in anti-racist teaching and a special contribution that the science department should be able to make to an overall programme of anti-racist teaching.

It could be argued, however, that classification is the wrong context within which to consider human beings and their diversity and variation. This could imply to the pupils exactly the opposite of what we intend, that is that there are scientific reasons and uses for the classification of people. We felt that it was important to put these two pieces of work together precisely so that the idea of the scientific classification of people could be challenged. (For discussion of these issues see **1.8**, **3.10**, **3.11**). The scheme of work which we developed and have now used with first year classes is outlined below.

We begin by looking at reasons for grouping things and situations where people often tend to group things. The first few lessons consider classification without reference to living things because we did not want to give the impression that classification in science is only used in biological contexts. The unit begins with the children looking at collections, trying to select as examples the sorts of things that the pupils themselves might collect. A lesson is spent in the school library, the children working with the school librarian. We raised question about who does these types of sorting things out, the reasons for doing these activities and the uses to which groupings are put. This is an essential part of the work since reference will be made to it at a later point in the unit.

We then go on to look at the grouping of living things, first into plants and animals and then animals are considered in more detail. We end the section of work by looking at one particular species — *ourselves* — emphasising the concepts of diversity and variation. This section of the work uses measuring skills and puts some emphasis on the communication of results and data. We felt that this was an ideal opportunity to use a computer for the analysis of some of the data collected.

The activities suggested were all based on the children working in groups. We wanted to emphasise the importance of contributions made by the pupils and to build in space for discussion.

Since the work was structured to give opportunities for group work there was less emphasis than before on writing skills and more on collaboration between pupils. Everyone could take part in the activities which included group discussion, preparing OHP transparencies, reporting back to the whole class and making posters for display. As all pupils were able to contribute to the work, motivation and enjoyment were high. Some of those who usually find difficulty in coping with written instructions and who frequently experience a sense of failure were fully involved and able to make valuable contributions.

First year pupils are still relatively uninhibited and very imaginative. They haven't yet learned all the 'correct' answers. There are rarely chances for pupils to use their creativity in science courses and some of them respond by effectively opting out from science as soon as possible. This work enabled pupils to make personal responses whilst working in groups.

The pupils were fascinated by the concept of themselves as animals. For many this was a new idea. Many of the points raised were followed up and extended in later work about growth and reproduction.

Pupils became very competent and confident at classifying: arranging collections in different ways using a variety of criteria. In doing this they began

to recognise not only the power and use of classification but also some of its limitations. Work on 'Ourselves' gave opportunities for exploration of variation and diversity within a species and led to interesting discussion both in groups and with the whole class.

We believe that the emphasis on collaborative work, group discussion and valuing and building on the ideas and contributions of pupils are very important features of this work. We now have to devise strategies for the development of this way of working throughout the department.

School B: 'foods' and 'science travels'

It is not always possible to work with a head of department and a group of teachers from the same school. I have chosen to describe the work done in this school because it resulted from the interest and commitment of one teacher. Some of the materials and ideas which were developed have now been incorporated into the work of the department.

Foods

The teacher wanted to develop work on food and nutrition which would relate as closely as possible to the experiences of the children in this ethnically mixed school. She asked pupils, in the two second year classes she taught, to write and draw about their favourite meal, the sort of food they had at home in the evening following a day at school and what they had for their main meal on a Sunday. Since the children were asked for a personal response, they worked in friendship groups as it was essential that they felt able to give a genuine response and not merely what they thought the teacher might expect.

We looked at the mass of materials they produced and found a very wide range of foods described. Some of the work was used as part of a display of information about food developed with the assistance of the school's Media Resources Officer (MRO). The MRO also photographed a range of foods for us, these photographs were also included as part of the display. A booklet was produced which included nutritional data for the foods which appeared in the display in addition to a very wide range of other foods.

A number of science teachers have developed a wider approach to the teaching of food and nutrition. One account is given in a booklet by a teacher in a ILEA school (**3.7**). Her account describes an anti-racist approach to the teaching of nutrition. The work described above is a multicultural rather than an anti-racist approach in that it encourages an appreciation of cultural diversity. To give a genuine anti-racist perspective, we would need to include a global perspective which looks at the inequalities of food distribution.

Science travels

The same teacher contacted me again after a year or so because she wanted to develop some work on the history of science with a world view. We hoped to be able to begin to counteract the prevailing view held by many pupils (and teachers) that science is the preserve of white people from a Western background.

The result of our work was a booklet which we called *Science travels*. It is designed for use with first year pupils soon after their entry to the secondary school although it has been used in this and some other schools with a range of children in the 11–13 age range.

We begin by asking 'Where has science come from?' (**3.12**):

> *The knowledge that we call 'science' has been discovered by people from all parts of the world. In this booklet you will be able to read about some of the knowledge that people have discovered at different times and in many different places. These ideas have been used by people and have often travelled with people as they moved from one place to another.*
> *The science that you will learn in school has widespread origins. This booklet tells you about some of these.*

After some discussion about people from many places finding things out and using these discoveries (e.g. paper, metals) we describe the trade routes which also served to facilitate the exchange of ideas. We then introduce other trade routes.

> *Also, hundreds of years ago in Europe ships were built to travel to the rich vast lands of the Americas, Africa and India. These ships brought back wealth in the form of gold, cotton and other raw materials. Many people who studied and used scientific ideas grew rich because they were able to exploit the wealth that came from trade. Many of the scientific ideas developed at this time were to improve the ships and navigation techniques need for trading.*

We describe how some ideas and information spread slowly round the world from India, China, Arabia, Egypt and Greece, hundreds of years ago, until it reached Europe.

A number of pupil activities are suggested. These include tracing the routes which ideas and inventions might have travelled on maps, making time lines for the inventions and discoveries described in the booklet and:

> *Imagine that it is 1005 AD and you have just travelled to China. Make up a story or play in which you tell people about gunpowder when you get back home. You may like to present your play or story to the class, write it down or make a tape.*

We have found that children respond very positively to this booklet and become interested in the ideas presented. The activities suggested produced great involvement and enthusiasm from the pupils.

We became very interested ourselves in finding out information on the world history of science. This has provided us with more ideas for materials which we plan to produce in the future. We try to consider how we can include the principles for developing an anti-racist perspective to our work. We do not claim that it is always easy but we have found that by working cooperatively as teachers in school-based curriculum development we are able to share ideas and increase our own awareness of issues involved.

Conclusion

It has only been possible to give fairly brief descriptions of work from two schools where the situation in the science departments with respect to school-based curriculum development are very different. There are some schools in ILEA where the whole science department is working together to develop anti-racist and anti-sexist approaches. I suspect that it is more usual for one or two teachers within a department to be involved in these issues initially and they then have to devise strategies for extending their perspective to include the work of the whole department. (Further reading will be found in sources of information in Section 7.)

I would like to acknowledge all I have gained by working with a range of colleagues and especially to express my thanks to Jenni Newnham, Catford County School, and Sally Moy, Sydenham School, with respect to the work described in this article. The views expressed are, however, my own.

PART TWO

Specific issues

SECTION FOUR

Assessment by profile

by Jane Harrild (School of Education, University of Bath)

During recent years there has been considerable interest in developing what have variously been described as Pupil Profiles, Records of Achievement, Student Portfolios and Comprehensive Pupil Reports. Much of this interest in the broadening and reorientation of the processes and techniques of assessment has arisen out of a growing sense of dissatisfaction with the limitations of the assessment practice currently prevalent in many secondary schools.

Beneath this dissatisfaction is the belief that there are more ways of developing an understanding of personal achievements than through a scrutiny, often impersonal, of a student's written work. Students, it is argued, have to be looked at within the total context of their wide and varied experiences whether these be inside or outside school. Many of their qualities such as creativity, imagination and persistence may only become apparent during the course of a learning process rather than in an isolated, written piece of work. It is precisely this type of personal quality for which traditional forms of assessment are inadequate as a means of description.

Profiling reflects a philosophy of education in which the student is active rather than passive, which is based upon students' wide and varied needs and interests and is intended to develop personal growth, self-awareness, social skills, self-esteem and autonomy. For students to be actively involved in their learning inevitably means that they must be similarly participatory in the evaluation of that learning.

Implicit in such a philosophy of education — and hence the rationale for profiling — is that these aims are appropriate for all students irrespective of race, gender, social class or ability. The remainder of this article will be concerned specifically with one of these major issues, namely race, attempting to demonstrate how both profiles and the process of profiling can result in racial stereotyping and a monocultural view of the world.

The underlying question is 'Profiles — all things white and beautiful?'

Aims underpinning science profiles

How then, will a reorientation of assessment practices enable science teachers adequately to reflect a reorientation of their teaching programmes along the lines indicated by a multicultural policy statement.

An example of a first draft science profile may be useful here in focusing attention upon the practical implications which arise in the development of a profiling system. In Box 6 the results of an initial 'brainstorming' session amongst the members of a science department are recorded as they occurred, with the skills and attitudes this group of science teachers wanted to assess or comment upon.

Given the embryonic nature of the profile plus the fact that it was subsequently revised and extended, certain interesting facts emerge.

1. The ability to observe, record and measure accurately.
2. The ability to work safely with equipment, materials and chemicals.
3. The development of manipulative skills.
4. The ability to evaluate results critically and analytically.
5. The ability to use equipment with understanding.
6. The acquisition of a vocabulary relevant to the subject.
7. The application of the subject within a social and environmental context.
8. The development of decision-making ability.
9. The development of an historical perspective of the subject.
10. The development of self-motivation.
11. An enthusiastic approach to the subject.
12. The ability to sustain investigation and perseverance.
13. Evidence of imagination, curiosity and creativity.
14. The development of an interest in and care of the environment.
15. The development of self-discipline.
16. The ability to work in groups.
17. The ability to work individually.
18. The ability to identify and solve problems.
19. The ability to plan work and predict results.
20. The development of confidence.

***Box 6** Skills and attributes proposed for inclusion in an assessment profile by a science department (St. Somewhere)*

There is very little in the profile that is subject-specific to science teaching. Indeed, there is much within this particular profile which other departments at St. Somewhere adopted as the core to their own subject profiles. In reality, a cross-curricular profile was emerging to which departments added what they regarded as subject-specific skills. It is also plain that much emphasis is placed upon personal and social attitudes or qualities, in this instance almost to the exclusion of subject-specific skills. Is this weakness inherent in the development of such a profile or an acknowledgement that all learning situations are essentially social situations and that much more is learnt

during lessons than subject matter – the hidden curriculum of school life? How, then, does the hidden curriculum operate in the laboratory or classroom and what will be its influence in terms of recording students' achievements in a profile format? What *values* are unavoidably being transmitted, both intentially and covertly, via the official curriculum in terms of its aims, purposes, content, methodological and assessment dimensions.

Content and aims have been discussed in Part One within the context of the science teacher's contribution towards the notion of education for a multicultural society. The question of the methodology and reorientation of assessment processes – namely profiling – now requires consideration; these two facets illuminate the idea of individual student worth, esteem and value.

Central to the notion of both assessment and profiling is the concept of judgement; usually the teachers' judgements made without much, if any, discussion with students. But central to the philosophy of profiling is the notion that teachers and students will enter into a dialogue based upon student progress and arrive at a mutually agreed statement. Furthermore, such agreed statements will emphasise positive student achievement, whether it is inside or outside of school, and as such will embody the premise that all students are of equal value and all have things to contribute to the learning situation.

Emphasis on the positive achievements of students is not synonymous with neglecting areas of learning where only partial understanding is perceived by the teacher. Indeed, in the formative, ongoing and continuous process of profiling, students become aware of their strengths and weaknesses, and learn to adopt a realistic attitude to their individual potential.

Educational questions which arise

The described rationale for using profiles will itself raise a multitude of questions about every aspect of school and classroom life. Questions such as the school ethos; does it encourage active student involvement in the learning process or are students required to be passive recipients of information? Is the school streamed or organised on mixed ability lines? Studies have indicated that differing organisational styles will have repercussions both for students' self-image and teachers' expectations of them in terms of performance (**4.1–4.3**).

Within the individual classroom, are teaching style and internal groupings having a subtle yet significant effect upon motivation and the developing self-image of students? When there is 'discussion' is it always teacher-centred: that is, is the teacher constantly asking questions to which she or he already knows the answer? Or, are students being, encouraged to discuss and debate issues in their own terms, whether the issues are sensitive or routine, in a supportive atmosphere? Clearly this has direct relevance to education for a multicultural society.

The physical context of the teaching room has to be considered when attempting to evaluate the quality of classroom interaction – both teacher/student and student/student. Is, for example, a laboratory the most appropriate environment for the discussion of some of the sensitive topics?

Language, too, will have a crucial effect upon classroom interaction and teachers' perceptions of student achievement. And, if there are in the school students for whom English is not a first language, what consequence will this have upon the judgements teachers make about those students' achievements? Making judgements is an important aspect of the teaching role but these judgements must be based on relevant evidence and be susceptible to change, not be the subject of whim, caprice, prejudice or bias. Students who are perceived as doomed to failure because of some aspect of their background are not being accorded their due respect as individuals and are, additionally being used as 'evidence' in the establishing of stereotyping notions.

Who is an ideal student?

In a consideration of the ways in which teachers' judgements of their students are formed, the concept of the 'ideal' student emerges. This appears to be a notion commonly held amongst teaching staff but will vary according to the individual educational philosophy and mode of teaching. Thus, a teacher who pursues a child-centred, informal approach to teaching will have a different concept of the ideal student to the teacher with a more didactic and formal teaching style. There is some suggestion, too, that subject-specialism will contribute to a teacher's ideal student concept. Is there an ideal type of science student? Someone, perhaps, who is extremely accurate, quiet, tenacious, precise, one who conforms to rules, able to use sophisticated scientific language, competitive and a convergent thinker or, alternatively, is such an ideal student creative, imaginative, expressive, cooperative, divergent thinker and an extraverted personality?

These examples are exaggerated and clearly not mutually exclusive but we must ask whether science teaching in the classroom does tend to discriminate against personality traits which are culturally influenced.

Dangers of stereotyping

Since profiles must of necessity reflect teaching

programmes and subject criteria, the implications for profile statements must themselves be carefully considered if they are to escape stereotyping and typification whether this be of race, gender, class or ability. The safety clause inherent within the profiling philosophy is the negotiation between the student and teacher.

Undeniably, negotiation and student/teacher dialogue will do much to dispel stereotypic aspects of any profile format but only if there exists a willingness, flexibility and acknowledgement on behalf of teachers to concede the possibility that profiles could indeed be simply reproducing stereotypes and categories rather than describing individual students. The quality of classroom interaction, teaching style, the physical environment of classrooms and laboratories, the language of teaching and profiles, classroom management, grouping arrangements and teachers' judgements will all have an effect upon the developing self-esteem of students, their motivation, attitude and achievement; teachers are significant adults in the lives of their students. So, if teachers adopt a crude labelling scheme – whether of race, gender, class or ability – then such devices will inevitably have serious repercussions for their students both during their school careers and after they have left the school environment.

Teachers need to develop the ability to perceive their own biases and psychological make-up so they can, at the very least, acknowledge and make public the values implicit within their teaching programme, for no teaching is value-free. Without such awareness, profiles will simply be yet another means of transmitting institutionalised monoculturalism and a middle-class ethos.

Action within the whole school

An underlying assumption of this article has been that education for a multicultural society is something that should be an integral aspect of the curriculum of every school, but this assumption is one not all will concur with. There is a view that to draw attention to cultural diversity is merely to exacerbate racial tensions, and that to embrace the multiethnic philosophy in education is quite simply to celebrate the control the white, middle-class establishment maintains over the curriculum. In other words, initiatives and new dimensions are allowed (or not) by the consent of those with power.

Quite clearly the institutionalised inequalities of race, class, gender and ability within schools exist. John Eggleston in a recent research study (**4.4**) expressed it thus:

> *The fundamental reasons for low attainment sprang very much more from the low expectations with which black children were surrounded. In part this was due to racist attitudes by teachers... They were deeply embedded in the hidden curriculum and could be seen in the almost surprised manner with which teachers spoke of the achievements of their black pupils implying that this was so unusual as to be worthy of special mention... The 'barrier use of language'... non-mother-tongue English speakers' difficulties with language tended to be subtly exploited rather than overcome and used as a further vehicle for differentiation.'*

Certainly, if the racist implications of multicultural teaching are accepted at all they are invariably expressed in the language of inevitability or lack of intent. Thus, frequently in the literature lack of a multicultural dimension to the curriculum is described as an 'unforeseen by-product' or 'an oversight'. No-one's intentions are ever queried but it is reasonable to suppose that this apparent naivety and overt monoculturalism represent deliberate social control.

Arguments about who is responsible for this state of affairs, and why, do nothing to alter the reality of the situation. The purposes of education for a multicultural society, purposes which are *not* based on an expectation that ethnic minorities will be assimulated or integrated into British society, have to be made explicit. The concept has to be discussed within the context of a school's ethos and whole curriculum rather than dealt with in a token, 'bolt-on' or cosmetic manner. We do not need the multicultural 'big bang' (such as food days, or the forming of a steel band, or peripatetic sitar teachers) but we want multiculturalism to be evident in the hidden curriculum, the atmosphere of the school, in out-of-school activities, in the playground, corridor and within the classroom as much in what we do not say as in what we do:

> *In short then, educating children for life in a multicultural society is a natural function of good teaching, not a distinct and specialised area.* (**4.5**)

This should be a function of *all* good teaching and, of necessity, an issue which requires a whole school involvement and commitment. Much of what has been written here has implications for all teachers, not just the scientists, as all have a positive contribution to make, and profiling is a potentially powerful strategy for achieving this goal. As James goes on to say (**4.5**):

> *Ultimately, our aim should be to enable all children to achieve autonomy and this includes independence from their own roots: they should be able to look at the ideas and work of any human being and judge them on their own merits, irrespective of the skin colour, cultural background or socio-historical location of their maker – to identify themselves with other human beings as fellow workers with a common interest in injustice based on race, sex or way of life.*

These are commendable and laudable sentiments, echoes of which reverberate throughout the 1985 report submitted by the Swann Committee (1.1), which could not:

> *...emphasise too strongly the urgency of the need for change where ethnic minorities are concerned... and stressed that cultural diversity had to be perceived as a central feature of the current debate on the balance and breadth of the curriculum. We believe* (the report states) *that everyone in Britain has a direct interest in ensuring that institutions and the attitudes which inform them, change and take full account of the pluralism which is now a marked feature of British Life...*

Multiculturalism has simply added another dimension to our educational priorities. An inability to meet the educational needs of students from a diversity of ethnic backgrounds is merely an extension of our failure to meet the needs of disadvantaged students of whatever kind. Sentiments and aims such as those expressed above might as well have been uttered by Winnie the Pooh for all the bearing they have on reality.

If we continue to ignore the multicultural reality of our society and the society of the world, by teaching (overtly and implicity) from the monocultural viewpoint, then this will surely be true: that if we will the means — a deficient and sectarian educational system, then we will the end – a deficient and sectarian society.

The views expressed are the author's own and do not necessarily reflect those of the project with which she is currently working.

SECTION FIVE

Science education in and for a multicultural society: some language issues

By Pauline Hoyle (South London Science Centre)

In science, language takes a particular form. Scientific reporting is concise and technical, it has its own *lingua franca* and is written in an impersonal style. As students of science many of us were taught to use this type of language. It made us feel we had joined 'the club of real scientists'. This form of language has helped make science distinctive and has acquired the kind of status that implies that you need to be familiar with and a competent user of this type of language if you are to have access to the knowledge and ideas expressed in it. This language helps to give science the aura of being a body of knowledge that is true, founded on verifiable facts and a system of incontrovertible laws and theories established in a rational and objective fashion.

This language is not the language used by scientists in discussing their ideas. This view of science is not accepted by all scientists, science teachers or philosophers. It is, however, reflected in the style of much reporting in science, it is thought to convey objectivity and it may be one reason why we as science teachers so often require our pupils to learn to use it. As science teachers we need to realise that this so-called scientific language can be very isolating for pupils. They can turn away from science because of the way it is expressed. As teachers and science educators we have often become habituated to turning a use of language that sought for precision and accuracy into jargon and never think twice about using the impersonal and passive style. We use it in worksheets and it is common in textbooks. Many of us realise that pupils will, in any case, have to cope eventually with the formal language of a science examination. But even if this is inevitable we need not make this our starting point.

If we consider all the situations pupils encounter at school we soon realise that they are very adaptable and have learnt to cope with a lot of variety in teaching styles, content, situations and ways of expressing themselves. They talk in one way to their peers in the playground, in another way when talking to adults in authority, and so forth. Linguists call these different ways of expressing ourselves in different circumstances 'using a different register.' 'Scientific language' can be considered as just another one of these registers. It is something that we may want pupils to learn but part of our role as teachers is to assist in its development and not use it as a starting point which can isolate pupils from science.

Current research about the ways children learn science (**5.1**) suggest that we need to start with the ideas pupils themselves have, challenge such existing ideas in the expectation that they may be restructured, and develop new ideas closer to scientific orthodoxy.

In expressing what they know, pupils explicate their ideas in their own terms. In the case of pupils for whom English is a second language, in 'their own terms' may also be in their mother tongue. Even those pupils for whom English is their only language from birth, the register will be different from that of a scientist — or science teacher. Such processes of challenge and re-examination also give pupils the chance to refine the language they use. This approach suggests that pupils need to be *actively* involved in their own learning, asking and answering their own questions in terms which they understand.

Through this process pupils may eventually learn to cope with scientific jargon and the register of science, if **their own language and ideas have been the starting point** of a discussion. If the initial discussion in a science area starts by using an isolating register then pupils are unlikely to learn the science or to want to become involved in scientific endeavour.

Language development

As teachers it is important then that we become aware of language development and its links with concept development. Such arguments have been well explored in the work of, for example, Piaget, Bruner and Chomsky. We communicate in science in many ways — using talking, reading, writing, and listening. Pupils do not necessarily develop equal competence in all of these areas at the same time. In general, they tend to acquire oral competence and confidence in any subject before they gain competence in reading and writing. In the following sections I shall describe ways of helping pupils to develop these skills in the context of science lessons.

Talking

If oral competence normally precedes competence in reading and writing then it is crucial that we science teachers begin by encouraging the development of oral skills; talking must be our

starting point in exploring scientific ideas. To many science teachers talk means pupils discussing last night's TV or the fight in the dinner queue rather than discussing the science they are doing. For others talk is what the teachers do, at the beginning or end of a lesson, to set the scene or give the lesson structure. For a teacher the ability to turn teacher talk, or teacher-directed discussions, into pupil talk where pupils use their own language or register to discuss an idea, is an essential skill if language and concept development are to be stimulated.

As an example of how to do it, imagine a lesson on tooth hygiene. How often have you stood at the front of the class and introduced such a lesson by asking 'How many people cleaned their teeth this morning?', or 'How long is it since you went to the dentist?' To turn this into a pupil-directed talk activity you could divide the class into small groups of 3–4 pupils and ask them to list ten ways of keeping their teeth healthy. You could also give them a 'starting' activity as shown in Box 7.

Keeping your teeth healthy

Instructions: Read the statements below. In your group, discuss each statement and decide whether it is healthy, not healthy, or makes no difference to the condition of your teeth. Write your decision in the box.

1.	Clean your teeth everyday.	
2.	Brush your teeth very quickly.	
3.	Eat an apple at the end of every meal.	
4.	Brush just the teeth.	
5.	Clean your teeth after eating.	
6.	Eat cheese at the end of every meal.	
7.	Clean your teeth with a soft toothbrush.	
8.	Brush your teeth and the gums.	
9.	Brush in a circular motion.	
10.	Use a mouth wash.	

Box 7 An example of a stimulus for pupil discussion

This type of activity gives pupils some direction for their discussion and so helps them to talk through and sort out their ideas and to learn from and to collaborate with each other. They can use their own language or register. They can bring their own experiences to the fore. It gives you the opportunity positively to exploit the variety of experiences pupils bring to lessons from their own cultures. For example, many of them may have experience of using salt or charcoal on teeth while others from different countries may have experience of chewing sticks. The message that all pupils get is that their knowledge and their ideas are important and are valued. It gives teachers the chance to hear what pupils know. It can also be the basis for pupils to start by asking their own questions and then begin using the processes of science, e.g. hypothesising about how to keep teeth healthy, testing out their ideas, interpreting data about dental hygiene.

This activity is particularly useful for English as a second language (ESL) bilingual pupils. It allows them to listen to their peers and to contribute when they can. Research into second language learning (5.2) suggests that bilingual pupils learn far more quickly and competently when they can *listen* for some time, especially to monolingual speakers. Also language is best learnt when the learner is focused on understanding and expressing a new idea (5.3). So for bilingual learners particularly, talking activities about new ideas or concepts are essential.

Writing

If language development is to be enhanced, it is often useful to precede reading and writing activities by discussion. As adults, when we try to write a job application or an article such as this we often talk about it first, do a draft, discuss this draft with people and then redraft. Pupils need to go through exactly this process – talking, writing a draft, talking and redrafting.

In science, pupils have to learn to write if not in the manner of many scientific reports then certainly impersonally. When pupils first develop writing skills it is usually the expressive mode that they acquire first. That is, they learn to write stories which are personal and involve feelings and emotions. It may well be that when a science teacher asks pupils to write up an activity they write what to many may seem inappropriate – a story about who did what and what happened when the teacher shouted, etc. (see Box 8).

Facts And Hydrogen 8/9/85

When I got in the Science room I first got a folder, two tags, a contents sheet and a paper to write the rules.
Then my teacher got 3 balloons, she let the balloons go and the balloon went up to the ceiling there were strings on each of the balloons.
Then my teacher lit one of the balloons it burned the strings until it got to the balloon.
When it got to the balloon there were sparks coming out of the balloon. Then the balloon busted.
My teacher did the same to the other two balloons, and the same thing happened.

Vassen

Box 8 Report from a year 2 bilingual pupil

The type of writing scientists most often engage in is called transactional writing. It is precise, concise

and seemingly objective. It is characterised by the writing we find in science journals. An example is shown in Box 9.

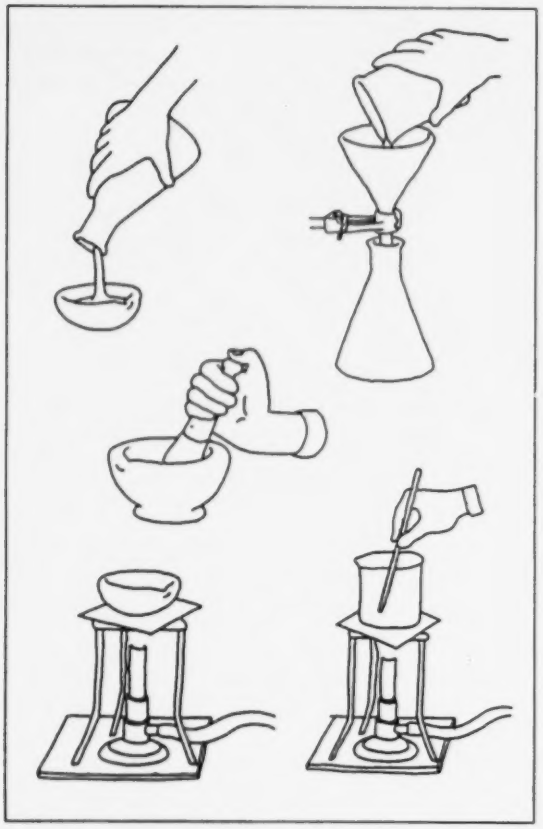
Materials and Method

The resistance of a length of Pelargonium stem was found by piercing the shoot with dress-making pins, located 15 mm apart, and connecting an ohm meter across them, set at the x 1 k range. (The distance separating the pins can be usefully increased to 100 mm where the rate of ascent is expected to be very rapid).

The cut shoot was fixed in a potometer filled with 2 M salt solution and while fluid uptake was followed in the usual way, the interelectrode resistance was noted every 30 seconds by briefly switching on the meter.

Box 9 Quote from The School Science Review **(5.4)**

If pupils are to develop the skills of impersonal scientific reporting, they need to practise them and to become familiar with models of such reporting. The example below (Fig.3) shows a strategy in which pupils sequence pictures in an order, then either match a sentence to a picture, or sequence a passage. These strategies help *all* pupils to learn both the style (objective, impersonal, concise) and the vocabulary used when writing in this way.



Many pupils fail to produce acceptable or appropriate written reports. It may be because they have not yet mastered the 'scientific style' of writing. This is especially true of bilingual/ESL pupils who seem fluent in English because they can talk well. But their writing may show signs of non-first language errors. Collaboration with ESL-trained colleagues may help in identifying these errors and a course of action that will develop pupils' writing skills. It is important for teachers to recognise that many bilingual pupils do have language competence; that competence may not be in a form that teachers can understand. It may be in Bengali, Gujerati, Cantonese or Spanish.

Bilingual writing should also be encouraged in a science classroom concerned with multiethnic and anti-racist education. Encouraging pupils to write in more than one language not only maintains or develops their writing skills in general but it gives status to the role of other languages. It clearly gives pupils the message that their language and culture are important and can be part of a science classroom.

Some children with Specific Learning Difficulties may also fail to write competently in science due to their stage of language development. Again collaboration with 'Special Needs' colleagues may help science teachers to develop other approaches to aid writing development.

Writing up the Rock Salt Problem

Instructions

1. Look carefully at the diagrams.
2. Cut them out and put them into the order in which you did the experiment.
3. Paste the diagrams into your book.
4. Read the sentences below. Cut them out and put them in the order which best describes how you did the experiment.
5. Write this as a paragraph in your book, underneath the pictures.

- and heated it gently until all the water evaporated.
- After it had cooled we filtered the rocksalt solution.
- First we crushed some rocksalt using a mortar and pestle.
- We collected the filtrate in the conical flask and threw the residue away.
- Finally, we transferred the filtrate to an evaporating dish.
- Next we dissolved the rocksalt in 50 cm^3 of water. We heated it while stirring for a few minutes.
- We were left with clean salt.
- We put on our safety goggles.

Homework:

Problem: You find that there are biscuit crumbs in the sugar bowl. Design an experiment to show how you could separate the biscuit crumbs and sugar, ready for eating again.

Remember to include:

1. Some large diagrams of the equipment and how you would set it up.
2. Some sentences to describe what you would do at each stage.
3. Test your ideas to see if they work.

Fig. 3 A strategy for familiarising pupils with reporting style and vocabulary

3 6 BEST COPY AVAILABLE

It is important that the audience and the purpose of the writing are well defined. Is it for the teacher to read, for another pupil to follow the activity, or for the class display board? The chance to exploit expressive and even poetic writing in science should not be forgotten. Pupils can use a lot of science ideas when they write expressively.

Reading

This aspect of language is possibly the one which science teachers construe as being most difficult for pupils. In the last few years a lot of energy has been put into ascertaining the reading level of textbooks and worksheets. When writing materials, we have been encouraged to keep sentences short and use words with a minimum number of syllables. But why? Does this help pupils read or more importantly does it help pupils develop their reading skills?

The purpose of a reading level score, as I see it, lies in helping teachers decide *how* to use a book or passage rather than whether or not we should use it. If we want pupils to *read independently* then it is important that the reading level of material matches or is below that of a pupil's reading age. However, if we intend to *help pupils to read*, then we can successfully use texts that have a higher reading level than pupils' reading ages.

The key then is how to aid pupils' reading. Much of the reading we require pupils to do in science is reading for meaning or understanding. This is quite different to reading for pleasure as one would a novel. To ensure that pupils read for meaning and understanding it is essential that we make their reading active. It is useful if pupils have talked about a concept before trying to read a text about it. If you as a competent adult reader have talked about multicultural education or language issues before reading this book then you are likely to respond more and find it easier to read.

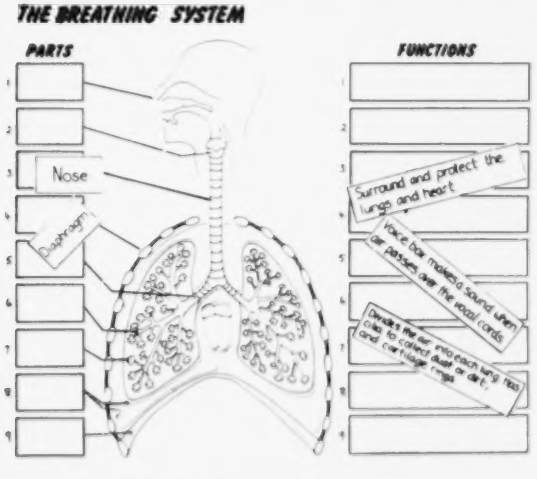

THE BREATHING SYSTEM
PARTS
FUNCTIONS
Nose
Diaphragm
Surround and protect the lungs and heart
Voice box makes a sound when air passes over the vocal cords
Divides the air into each lung's tube to collect dust or dirt and can muscle rings

Fig. 4 An exercise to stimulate active reading

Allowing pupils to talk, to collaborate and share ideas when reading helps develop their reading skills. In the activity shown in Fig.4, pupils have to read each card, decide whether it is a part or a function card, and then match it to the appropriate place on the board. They can predict the function of each part, match the function cards to their ideas and then test their predictions by using books, charts, etc. Pupils get actively involved in this process. They use their own ideas, read for meaning, talk and discuss their ideas and learn!

There are many examples of activities of this nature (they are commonly referred to as Directed Activities Related to Texts, or DARTS). This terminology was summarised by the Schools Council's project 'Reading for learning in the secondary school'. Such techniques show us how similar reading is to the processes of science. When we read we hypothesise about what is likely to come next, test our ideas by reading on and then interpret what we've read and adjust our hypothesis/theory accordingly.

The 'cloze' procedure (or gap filling) is a good example of this process. If I leave out a regular ..... of words in the paragraph about ..... you as fluent readers can predict, hypothesise ..... test what words are missing. For language ..... be developed alongside concepts it is ..... that words are left out by ..... regular count rather than just the science words.

Davis and Greene (**5.5**) have demonstrated how science teachers might use a variety of techniques to make reading active. Using these techniques means that the reading aspect of language can be developed in science lessons.

Listening

This skill has already been mentioned. Listening is inextricably involved with talking. Many of the strategies described for encouraging pupils to talk about their ideas are also those to use for listening to their peers. Making sense of what others say is an essential step in learning and sorting out their ideas.

Bilingual pupils in particular need opportunities for listening to a variety of registers, especially peer-registers which they are likely to acquire more rapidly than adult registers. They can often understand more than they can say especially when they first start learning a new language.

Teachers also need the chance to listen to pupils. This allows them to hear and understand what pupils are thinking even if they express it in a supposedly non-scientific way. If the ultimate goal is to allow pupils access to scientific thought then a gradual movement to scientific register is important.

Creating the proper climate

Many science teachers can now identify and begin

to remove both sexist and racist stereotypes from materials they use and include examples of scientific practice from other countries. But in many ways this is only a start. There are much more fundamental issues we need to address in anti-racist science education, e.g. what do we mean by science; what counts as 'science' or being 'scientific'? Is it only science from a laboratory that is given status or is valuable science also used by the person in the street attempting to understand and solve a problem using scientific processes?

The strategies we use in our classrooms need to reflect our attempt to make our classrooms anti-racist. The strategies suggested in this paper make an attempt to value and build upon pupils' own experiences and ideas. They allow both monolingual and bilingual pupils' languages and registers to be valued. Pupils will mouth/reflect the racism in our society. They will say 'I'm not writing in Punjabi', or whatever language they can write in, if the school environment does not value the ability to express oneself bilingually. So it is important that language issues are raised across the curriculum and developed in all classrooms. A school language policy may help develop the importance of pupils' bilingualism.

Care with language can contribute to an anti-racist approach to science. But the type of science we choose to teach is also important. In a multicultural society people hold a variety of explanations or answers to problems. It is important that pupils are allowed to realise that a scientific explanation is only *one* explanation. By encouraging pupils to use the processes of science they can learn to consider the scientific answer as *one* answer rather than science being a repository of *the* answers. In this way we allow pupils access to learning which enables them to decide upon and value their own ideas.

PART THREE

Steps a science department can take

SECTION SIX

A process approach to in-service education for the science department

by Martin Hollins (North London Science Centre)

An increasing number of local education authorities are encouraging schools to write policy statements on anti-racism and multicultural education, usually modelled on authority guidelines (**6.1**) and often setting a short term deadline. Many teachers have felt dissatisfaction at the way such statements have been produced; emphasis on *product* seems to have inhibited the *process* of raising staff awareness of the issues involved. I think it is important for science departments to learn from this, as they tackle these issues in science, so this article reviews the processes which science teachers should consider, and avoids specifying aims or products to be achieved. Science is not made multicultural and anti-racist, I believe, by producing the perfect worksheet or the best-qualified pupils (though it may include these things); what is needed is **increased awareness** by teachers of their pupils and of the relationships between them and society.

The process, as I see it, originates from three premises (Box 10), which give rise to three general problems to be solved (Box 11). This section presents a range of strategies with which to tackle these, and briefly describes specific in-service activities which groups of teachers have used in the process. I shall take each general question in turn, stating it and describing the strategies appropriate to it.

a. A change is needed in the way science is taught.
b. Each individual science teacher has a responsibility to consider the nature of that change and its implications for his or her teaching.
c. The science department is the most appropriate agent for identifying and implementing the change needed.

Box 10 *The three premises*

- **Destination** – members may not agree on where they want to get to.
- **Origin** – members will not be starting from the same place in their practices and perceptions. These will largely be dependent on their previous experiences as teachers and as members of society.
- **Route** – members may have no idea about how to get from origin to destination, or may all differ in their views of how to change.

Box 11 *The three general problems that arise.*

Destination: How can we agree, or at least agree to differ?

Find the common denominator

The issue is introduced by making a statement which all staff can agree about, such as 'We all want each pupil to learn more successfully in science' and then, through a structured discussion, analysing what this might mean in the context of an ethnically diverse school or class. This has the advantage of stressing the common experience of all members and may be a useful starting point where differences of opinion and experience are anticipated.

Personal commitment

Each member is asked to state quite simply what they think; what they can contribute to the issue, or what their understanding of the issue is. This approach is less threatening if these statements are initially written anonymously and subsequently discussed perhaps in very small groups. The emphasis of the discussion should be accepting of different views, but if there is a challenge or condemnation of some of the statements, the authors need not expose themselves at this early stage. Refs. **6.2** and **6.3** are sources of ideas I have used with a number of different groups of science teachers.

What destinations have others recommended?

This involves a review of current thinking on a general issue such as the aims of anti-racism contrasted with cultural pluralism and assimilation (for reviews of perspectives on education and race relations see **3.5** and **6.4**) or a specific issue for science such as the use of the term 'race' (**6.5** and **1.6**). (Many biology text books still imply scientific bases to racial classification, for example). To ensure at the beginning that all members feel included in this process, it is important to present a *range* of views for discussion, so that those who are new to the debate can explore them for themselves and not feel presented with a foregone conclusion.

These three strategies are each intended to be an open-ended approach to solving the problem. The aim is to encourage each member of staff to express her or his view and to be prepared to understand

different views. If a consensus emerges at this stage about what you are aiming for then the process of defining where everyone is at, and how they are to change, becomes straightforward (although not necessarily easy!). If there are important differences in purpose between members, it is best that they are recognised at the outset, so that strategies for change take account of these.

Origin: Where are we at and how did we get here?

Personal awareness

A range of techniques have been used to help individuals improve their awareness of their own attitudes, usually under the title of racism awareness training. Encounter groups provide the most demanding example of this approach where participants engage in a no-holds-barred exchange of views save for some very basic ground rules such as no physical violence! Liberated from the normal constraints of social intercourse, members of the group confront their own attitudes through a very direct relationship with others in the group. Needless to say this can generate very strong feelings and requires a trained facilitator. This strategy can be used in a less threatening way by providing more structure. For example each member might be asked to describe themselves briefly and to follow this with a discussion of these personal perceptions. If there are teachers from ethnic minorities, they will most probably include this in their description, those from the majority will probably omit this. Other starting points for discussion might be to describe an experience of racism, or other type of prejudice or discrimination. The focus of the discussion is on individual personal response and learning from each other of differences in experience.

A recent television programme (**6.6**) showed extracts from an extended awareness training exercise (facilitated by John Heron). Over a period of three days one of four avowed racists changed her attitudes dramatically.

Review the *status quo*

This is an obvious strategy whenever one wishes to embark on change. Multicultural or anti-racist issues may arise naturally as part of a general review of the science curriculum, or they may provoke such a general review (**6.7**). More specific activities which help focus attention would be to present a review of the LEA's or school's policy statements and to discuss how they came to be implemented (**6.8**); to review resources which may be useful for science teaching (refs. **6.7** and **6.8** contain bibliographies and reviews of resources); and to look for stereotyping and bias in science texts (**6.9**). (Also see the Appendix.) All these activities are relatively straightforward to undertake, though a department may need to find someone to present the opening talk in a review. They will provide an acceptable starting point for many teachers who are apprehensive or unsympathetic to the idea of multicultural and anti-racist approaches. These are not in themselves challenging activities and may encourage members of staff to express differing views in a situation where no actual demands are being made on them. The danger is that this can encourage a passive response.

Route: In what ways do we bring about change?

The solution of this problem by the science department depends on the results for the previous two. Clearly the implementation of change is affected by origin and destination, especially if differences in both have been identified amongst members of the department.

Changing society

It is a matter of debate to what extent schools reflect society and to what extent they can shape society, in racism as in other matters. It is certainly arguable that neither can wait for the other to change, and teachers need to be active both inside and outside school. It is important, however, that the two activities do not conflict if the teacher is to maintain credibility with colleagues, pupils and others (**6.10**). It may be that a science department can increase its commitment to change by some corporate activity outside school, without damaging that credibility. Involvement in campaigns of a social and political nature, for example in connection with housing or immigration policy, can certainly raise teachers' awareness and may give a sense of solidarity. These are important facilitators of change, even if the activity itself seems to have no direct connection with the science curriculum.

Producing policies and priorities

If these are to be other than cosmetic it is essential that staff feel fully involved in the process of producing them. The problem is to find enough time for this process. If some time has been spent on the first two problems at least the department will be attending to the real issues here, and not some alternative agenda. One way of getting to grips with policy writing and priority setting is to simulate the exercise using ready-prepared statements (some important, others not) and/or staff in roles to support particular interests. This may allow departments to move more quickly beyond this to achieve an end result in the all too limited time available (**6.2** and **6.11**).

Organising change and changing the organisation

It is necessary to raise department members' awareness that things can be done in a different way. The way certain things *are* done (e.g. staff appointments, timetabling, writing new courses) *can* have a racist bias, and may need to be challenged. Here again a simulation exercise can be useful for staff to explore issues in a less contentious situation (**6.12**).

Reflecting on classroom practice

The classroom is the place where pupils experience changes in science teaching, so it is essential that this is carefully reviewed. There is plenty of evidence from studies on sexism in the classroom that the intention to be anti-sexist does not guarantee even non-sexist practice. In most situations the teacher will have to review his or her own practice, which is difficult. This self-evaluation may be helped by departmental discussion, perhaps following a videotape of a lesson or observation of teachers by each other. The department could produce a simple checklist for teachers to use. Material produced for sexism awareness may be modified for this purpose (**6.13**). It is important that such a device is accepted by staff as being worthwhile for encouraging reflection and possibly an analysis of practice, and not seen as either a waste of time or a threat.

Curriculum planning

Many departments have found the best way to include multicultural and anti-racist issues in the science classroom is to build these in during a general review of the course, e.g. including issues such as variation in the human species, multicultural nutrition and the economics and politics of food distribution: in third year. The department might start by relating its policy on multicultural education and anti-racism to the aims of the course. Planning might involve simply a revision of existing material or a more fundamental analysis of what pupils require (**6.14**). In most cases the major activity will be group discussion to establish objectives, followed by more detailed planning by a smaller group or individual teacher, serviced by any appropriate resources.

Writing course material

This follows naturally from curriculum planning, and as readers will know can last for ever! There is a need for written materials for pupils (and teachers) at all levels to raise these issues in interesting and practical ways in the classroom — very little exists for science at present. I have compiled two booklets of classroom activities, discussions of issues and reviews of resources and sources, written by London science teachers (**6.15**). Sharing the task is one way to reduce the burden and it may be worth looking outside the science department and to other schools for help in this way. The second is to become part of an information network to find out what others are doing and let them know what you are doing. Fostering this has been an important role for the ILEA science centres and some other teachers' centres and departments of science education (**6.16**).

Conflicts: What if the problems cannot be solved?

The strategies I have outlined show how a relatively straightforward sequence of activities might facilitate the changes which a department wishes to implement. The time-scale will of course depend on degree of change, and of commitment. If serious conflicts arise in the department, a number of further strategies may be worth considering:

- *Brainstorming*, where everything is accepted as a possibility to begin with, and examined critically later. This enables everyone to contribute more freely than when there is pressure to produce the best solution (**6.17**).
- *Small group* work also encourages people to express themselves more freely than in plenary session. One strategy involves a gradual build up of group size by pairing, with a negotiation of priorities at each step.
- *Role play* or simulations enable people to expose attitudes and opinions they would never countenance in 'real' life. If there are great differences within the department a subtle cross-casting in an exercise can be enlightening for participants.
- *A clearly defined aim* for the in-service session helps – if that aim is defined by someone who is not already in the conflict! An external facilitator such as an experienced teacher from another school, advisory teacher or Teachers' Centre warden can be very useful for this.
- The most likely problem left unsolved is that everyone unthinkingly agrees that something should be done, but no-one gets around to doing it. The issues need to be given a higher priority by some kind of provocation. To be effective this probably needs to emanate from outside the department. It might be a lecture asserting that science is racist, or a session hearing of local examples of racism. The degree of confrontation needs to be carefully matched to the department's level of awareness and follow-up is very important, both to capitalise on the stimulation produced and ensure that no-one felt completely overwhelmed or offended by the experience. Ref. **6.18** is a review of escalating exposure of staff to anti-racist views.

A shared expertise

I would like to end on an optimistic note. Underlying my three initial premises is another – that *all* science teachers' experience of, and training in, their subject should leave them:

- convinced of the inevitability of change, and
- open-minded enough to analyse the needs of their pupils and to work towards the meeting of these needs.

SECTION SEVEN

SSCR recommendations and sources of information

Recommendations

For convenience our recommendations are organised under three headings: those relevant in the whole school context; those pertinent to the science department; and those which should be implemented in the classroom. Many of the recommendations arise from the preceding articles, others have not really been touched upon and therefore require some explanation. Although the recommendations are specifically addressed to science teachers, we acknowledge their relevance for all teachers.

We believe that all science teachers should take steps to provide a science education appropriate for youngsters growing up in a multicultural society.

Within the whole school this means

- operating within a whole-school multicultural policy. This will involve contributing to the development of a school policy and then ensuring that the science department reflects this policy as closely as possible.
- using all appropriate opportunities to challenge prejudice as and when it arises in the school community.
- ensuring a consistent approach to dealing with racist incidents in the school.
- wherever possible, organising for all teachers to gain some experience of different cultures. One strategy might be that of gaining experience of schools with diverse cultures.

In the science department this means:

- developing a policy for the teaching of school science from a multicultural perspective in a way that will seek to counter the causes of inequality and prejudice. There are many examples of both school and authority-based policy statements – some are general whole-school statements, and some about science itself – which might help as guidelines (viz. the Leicestershire science policy in Section 2).
- ensuring that all members of the department are provided with in-service training to aid them in implementing policy. This may mean attendance at courses or allocating time at science department meetings to engage in activities like those suggested in Section 6. There is also an SSCR workshop on 'Cultural Images' (7.1).
- reviewing their approaches to language in science to take into account the role of science education in language development (see Section 5).
- collaborating with ESL (English as a Second Language) teachers to share expertise.
- considering the values which underpin assessment schemes (as suggested in Section 4).
- ensuring that resources do not contribute to stereotypical views or carry racist implications.
- using and developing links with parents and other members of the local community in order to gain a better understanding of different customs, diets and religious beliefs.

In the classroom this means:

- adopting a view that sees cultural diversity as a positive advantage. The potential to use the varied experiences of youngsters from different cultural backgrounds ought to be seen as adding richness to the curriculum.
- exploiting the opportunities that school science provides for teaching in a multicultural context. The companion SSCR Guide, **Better Science: Choosing content** lists many areas of study open to such developments, for example 'genetics' and 'communication'.
- challenging notions that ethnic origin places limitations on individual potential. Stereotyping of individuals means that the variation which exists within cultural groups is forgotten while the differences between groups is emphasised. Teachers of science are in a strong position to challenge such biological determinism.
- demonstrating the validity of technology in particular cultural contexts. Viewing technology as a response to human need means investigating the notion of 'appropriate' technology. Therefore study of both the positive and negative implications of particular technologies should be part of the science curriculum – as argued in Section 1.
- illustrating that science has different implications for individuals in different parts of the world. That is, the differential application of science and technology can discriminate against different cultural groups. For example, it could be argued that the 'green revolution' which was considered by Western scientists as providing a solution to famine in the Third World actually caused extra hardship for many subsistence farmers whom they were trying to assist.
- setting Western science in an historical context which illustrates that it is relatively young in terms of the history of science. For example, the emergence of Western science in the 16th and

17th century can be compared with the long established practice of science in China and the Arab world.

As was stated in the introduction, the issue of 'science education for a multicultural society' is a relative newcomer to the agenda of many science teachers, particularly those who teach in schools with few students from ethnic minorities. We hope that this Guide has served to encourage readers to consider our proposals and try out some of the approaches.

Useful sources of information

The full list of references given at the end of the Guide provides many pointers to further reading and useful curriculum resources. We refer readers to the following publications in particular as being more generally useful.

1 **Science Education for a Multicultural Society,** Leicestershire LEA. This has already been referred to extensively in the article on the development work of SSCR groups in Section 2.

2 **Science Teaching in a Multi-Ethnic Society; a handbook of suggestions and resources,** ILEA 1985. **Science Teaching in a Multi-Ethnic Society Book 2: Issues, practices, resources**, ILEA 1986.

These are both edited by Martin Hollins (see Section 6) and are obtainable from North London Science Centre, 62-66 Highbury Grove, London N5 2AD. Both publications provide discussion papers, ideas for teaching and extensive references to other helpful sources of information.

3 **Third World Science** produced by The School of Education, University College of North Wales, Bangor. Available from the Centre for World Development Education, Regents College, Inner Circle, Regents Park, London NW1.

This is a series of pamphlets containing information for teachers on science activities in the Third World for use in British schools. Individual titles include: *Carrying loads on heads, Charcoal, Clay pots, Dental care, Distillation, Energy converters, Fermentation, Housing, Iron smelting, Methane digesters, Natural dyes, Plants and medicine, Salt, Soap, Pupils' project from Zambia.*

4 Rosen, C. **The Cambridge Illustrated History of the World's Science,** Cambridge/Newnes, 1983.

5 Haber, R. **Black Pioneers of Science and Invention,** Harcourt Brace Jovanovich, 1978.

6 Bynum, W.F., Browne, E.J. and Porter, R. **Dictionary of the History of Science,** Macmillan, 1983.

These three publications are sources of information on the contributions of other cultures to the development of science.

Glossary of terms

Teachers who are new to the issue of multicultural education may find the following explanations of terms useful – adapted from *Agenda for Multicultural Teaching* by A. Craft and G. Klein, SCDC Publications, Longman, 1986.

Multicultural and anti-racist education: Different people place different emphasis on these two terms. *Multiculturalism* stresses the need to acknowledge and draw upon cultural diversity. This applies to all schools irrespective of whether they have students from ethnic minorities or not. Proponents of an *anti-racist* approach argue that the main problem is not one of 'culture' but of 'racism'. Anti-racism therefore, gives greater emphasis to the attitudes and practices which discriminate against some (especially black) minority groups and which results in an unequal distribution of life chances. As noted in the Introduction the two terms are not mutually exclusive; successful practice occurs with both approaches.

Assimilation: By and large an outdated response to ethnic minority children in British schools. The aim was to absorb the children into the host community, to teach them the English language and customs so that, it was argued, they could compete on equal terms. Disappointment with the results has led to an acceptance of cultural diversity and an emphasis on appreciating such diversity within the education system.

Cultural diversity: The variation in language, religion, country of origin and physical characteristics (particularly skin colour) between people.

Ethnic minorities: A loose term used to refer to groups which share some or all of the following: a religious affiliation, a linguistic and literary heritage, a common history, and who experience a common geographical origin. The most frequently identified characteristics of ethnic minority pupils in British schools include a home language which is not English, a religion which is not Christian or a skin colour which is not white.

Ethnocentrism: The tendency to view events from the perspective of one's own culture and ignore other cultures.

Swann Report: Many writers refer to the Swann Report *Education for All* which was published in 1985 (HMSO). This is the report of a government enquiry into the education of ethnic minorities in Britain. The proposals in the report focus on the need for multicultural education for all youngsters and the responsibility of all Local Education Authorities to combat racism.

APPENDIX

A checklist for analysing images in teaching materials and curriculum resources: an in-service activity

1 *Examining images of science*
- Is the application of science illustrated with examples from all over the world?
- Is up-to-date technology only illustrated by Western examples?
- Is science set in a context which relates to people?
- Does the way in which the material is presented suggest that only Western ways are valid?

2 *Examining images of people*
- Are the people featured in the material from more than one cultural background?
- Does the material present a positive view of people from different cultural backgrounds? For example are they illustrated performing tasks of equal esteem?
- Are the negative images confined only to people from a particular cultural background?
- Are people who are considered eminent scientists from different parts of the world represented?

3 *General*
- Is the material presented in such a way as to eliminate damaging feelings of superiority, based on race, in the European person?
- Are the customs, life styles and scientific traditions of people presented in a way that helps to explain the value, meaning and role of customs in their lives?

4 *Discussion themes*

After examining the material, you may like to consider:
- the validity of the images presented by the text;
- the effect of these images on the attitudes of youngsters;
- the ways that teachers compensate for deficiencies in the materials.

References

The SCCR publications referred to in the text under the series title **Better Science** are not listed here.

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1.5 *The Times Educational Supplement,* 30 August 1985

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1.7 Hollins, M. *et al.* (eds) *Science Teaching in a Multiethnic Society II,* North London Science Centre (62-66 Highbury Grove, London N5 2AD), 1986

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1.9 *Nu-Pack* (obtainable from ILEA Computer Centre, Bethwin Road, London SE5 OPQ)

1.10 HMI. Curriculum Matters 6, *Health Education 5-16* (particularly paragraphs 40-49), HMSO, London

1.11 *Science and Technology in Society* (SATIS) materials published by The Association for Science Education, Hatfield

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2.2 S. Wales SSCR group. *History of Science* (to be published by the ASE)

2.3 *Third World Science* (curriculum materials obtainable from the Centre for World Development Education, Regents College Inner Circle, Regents Park, London NW1)

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The Secondary Science Curriculum Review (SSCR) was set up in 1981 to stimulate, through working groups of practising teachers, the development of science studies which would help to provide an appropriate science education for *all* young people growing up in a scientific and technological society — whatever their abilities or career intentions. Its concern was not only with the science curriculum — its contents, purposes, teaching methods and resources — but also with the role of science in general education and within the whole school.

The **Better Science: Curriculum Guides** are based on the combined experience of the Review's Central Team and the working groups. Each Guide deals with a different but significant area of concern. Together they aim to assist teachers both in devising a broader and more balanced approach to science studies and in enhancing their professional development. The intention throughout is not necessarily to provide answers but rather to provoke and encourage teachers' thinking about the various topics addressed.

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- raises some major issues through six articles;
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